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**Can AI used in accounting  
help manage sustainable performance  
measurement and reporting?**

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## INTRODUCTION

In recent years, artificial intelligence has become more and more an integral part of our daily lives. The first definition of Artificial Intelligence was probably the one developed in 1955 by John McCarthy, one of the greatest computer scientist and cognitive scientist recognized as the founder of AI who stated that: "*Artificial Intelligence is the science and engineering of making intelligent machines, especially intelligent computer programs*" (McCarthy, 2004). However, it is clear that although AI was associated to the related work of utilizing computers to comprehend human intelligence, it should not be limited to techniques that can be observed biologically. Essentially, it consists in a set of different technologies that interact to enable machines to perceive, understand, act and learn with human-like levels of intelligence. Think, for example, of AI facial recognition mechanisms, rather than virtual assistants or chatbot which we use almost every day both while working, studying but also in our free time. As it is clear the spread of such technologies has been changing many things and redefined the job descriptions of many sectors of profession, among which accounting is widely included.

In the accounting field, Environmental, Social and Governance pillars are some of the most important issues that nowadays our society is called to confront with. It is not surprising, then, that businesses are being considered main players in this battle, asked to convert their economic production towards more environmentally friendly, ethical and socially proactive sites.

Prior research has focused on the relationship that might exist between AI and Accounting, resulting in a prevailing positive result. Indeed, accounting information systems based on AI technology can increase decision quality, precision of financial reporting and even firm success. Moreover, AI used in accounting may lead to get greater results in financial management since it can help automating mundane tasks, processing large amounts of data and identifying patterns and outliers. Nevertheless, relatively little studies have been done about the correlation of AI and sustainable performance measurement and reporting. So, which is the companies' position towards this? In which way does the AI tools might influence the sustainability reporting within a business?

The aim of the thesis is to understand the impact AI has now and potentially could have in ESG reporting within a business, also by analysing already existing application of AI tools for sustainable reporting in real companies, highlighting strengths, weaknesses, challenges, and possible opportunities for improvement.

In order to produce this paper, in conjunction with the methodologies indicated above, it was useful to introduce sporadic excerpts from professional literature that takes into account the progress achieved by the Big4, which makes it possible to examine which technologies are actually used in the field of accounting and which are only applied on a theoretical level, either due to legislative gaps or due to issues of practicality, digital skills and costs. From the publications on the specific websites of each Big4, several publications were found related to new AI technologies in accounting and ESG reporting.

This was done because understanding the framework in which analyses have already been carried out allows the study to be contextualized and research hypotheses to be elaborated. Constructing the background makes it possible to identify which aspects have been subjected to greater analysis and which to gaps, in order to choose and delimit the research area of the research topic correctly.

In order to search for papers on which to base and thus produce an overall exhaustive and coherent analysis, keywords were first selected in ad hoc search engines such as Scopus and Google Scholar, related to the fields of accounting, ESG reporting and artificial intelligence, both at a general level and at the level of techniques for applying the latter to accounting. These words were combined with each other through the use of Boolean operators such as 'or' and 'and'. Subsequently, it was of course necessary to skim the results found, filtering the search within a limited and sufficiently recent time range and including inclusion and exclusion criteria. The types of documents used included reviews, journal articles, conferences, and book chapters concerning both financial economics and artificial intelligence.

The first chapter of the thesis gives an overview of the theoretical framework of sustainability accounting and ESG. Afterwards, the paper examines the standardization of the topic and its legislation, analyzing how the standards provided by the Global Reporting Initiative and the Framework of the European Union are reflected in the reporting of major international initiatives.

In the following chapter, the actual role of Artificial Intelligence within companies and its correlation with accounting and sustainability accounting operations is illustrated and accurately commented. This section focuses on research and explains how AI can be used in the process of sustainable performance measurement and reporting in order to demonstrate if there is a positive relationship between the efficiency of ESG reporting and the increase of AI tools.

The third chapter describes the methodology used.



Next, concluding case studies, based on two interviews, demonstrate these principles in a practical, real-world context. These case studies are based on interviews lasting approximately one and a half hours with targeted questions, developed in Chapter IV. While the first two chapters aim, first of all, to frame the scientific literature and, in general, the sources that were consulted and analyzed, as well as to contextualize and comprehensively define the topic; the IV aims to understand the actual application, operation and support that new artificial intelligence technologies can offer now and in the future.

Finally, a presentation of the results and conclusions is provided.

# CHAPTER 1

## SUSTAINABILITY ACCOUNTING:

### Contextualization of the topic and relevant regulations

#### 1.1 Introduction to sustainability accounting

Defining sustainability may seem intuitive and relatively straightforward, but it is such a broad interconnected concept that it is often extremely complex to define it precisely. Indeed, sustainable development requires an integrated approach that considers not only economic but also social and environmental issues. This idea was born thanks to a 1987 report by a UN Commission headed by Gro Harlem Brundtland, who defined sustainability as *'meeting the needs of the present without compromising the ability of future generations to meet their own needs'* (United Nations General Assembly, 1987, p. 43)

Furthermore, the concept of sustainability is more and more present in businesses and aligned with the 17 Sustainable Development Goals (SDGs) that are the focus of the 2030 Agenda, which represents a shared vision for all member states and promotes peace and prosperity for people and the planet. Specifically, then, The United Nations' Sustainable Development Goals (SDGs) are an urgent call for action by all countries at all levels of development that provide a global framework for achieving global development while balancing social, economic, and environmental sustainability (Mio, Panfilo, Blundo, 2020). Indeed, they face challenges such as reducing inequalities as well as promoting economic growth, fighting against poverty and seeking strategies that improve health and education while still paying attention to climate change and preservation of oceans and forests. Essentially SDGs can be depicted as *"an interconnected set of measurable goals designed to address interrelated challenges and achieve global sustainable development. They are addressed to all actors in society: governments, civil society, nonprofit organizations, and the private sector."*

Even though businesses play a crucial role and vital contribution in achieving the SDGs, it is undeniable that it is still needed to understand the role of organizations in tackling sustainable development based on the SDG framework and their role as sustainable development agents.

(Wicki & Hansen, 2019). Given that, the concepts of sustainability, SDG and social and human development on a global scale become closely interconnected.

Nowadays, particularly in the world of business and finance, the issues of privilege, social justice, ethical and environmental consequences are more relevant than ever. Indeed, a growing number of companies are playing an increasingly active role in achieving sustainable development goals, partly under the dictate of laws and regulations, but also partly due to more informal processes related to the need to obtain social licenses to operate (Verbin, 2020). Therefore, monitoring and supporting the responsibility of companies to take part in the process of sustainable development, or at least to disclose how their activities have sustainability impacts, has become of utmost importance.

Given these considerations, it is necessary to introduce the concept of Corporate Social Responsibility (CSR), which is the idea that companies should operate according to principles and policies that have a positive impact on society and the environment. It consists simultaneously of an idea or set of social expectations and business practices and overlaps with a large amount of other concepts like ethics, citizenship and sustainability. (Moon,2014) Therefore, its assumptions, definition and implications for business and society should be dynamic. Through CSR, companies make decisions based on financial gain and profitability while considering the impact of their actions on communities and the world at large. CSR goes beyond legal obligations: by voluntarily adopting ethical, sustainable, and responsible business practices, companies seek to benefit consumers, shareholders, employees and society as a whole. (IBM, 2022) Then, CSR can be described as the idea that businesses have an ethical responsibility to their stakeholders to act positively within their communities and environments and differs from the concept of mere sustainability, since it is a branch of the latter one focused on a company's ethical responsibilities towards its stakeholders; while sustainability is a broader, long-term concept based on a principle of ethical responsibility for what is right for the world and its future.

Nowadays, especially at the level of CSR, investors, business partners and customers make more and more complex and precise requests than a few years ago. This leads to a situation where sustainability for companies translates partly into compliance with regulations and best practices and partly into strategic and proactive business development, as it has been repeatedly shown that companies with sustainable business models often have a competitive advantage in the market. (Marczewska & Kostrzewski, 2020)

Therefore, many environmental challenges, such as climate change and pollution, or ethical

and social challenges, such as the consequences of using artificial intelligence, are receiving primary attention and scrutiny in corporate frameworks. Moreover, the focus of multiple discussions worldwide, precisely concerns the use and the monitoring of data through AI to influence the choices of individuals, i.e. the power of tech giants such as Apple, Google and Microsoft, which could be described as almost monopolistic. (Petit, 2020). It follows that, in order to fully understand the impacts of AI, first of all it is advisable to track environmental, social and governance risks with timely data, not only through maps and reports but also by including an analysis of the SDGs, to be specifically aligned with the three ESG aspects (Sætra, 2021).

On the other hand, the achievement of several SDGs can be greatly simplified by the fact that artificial intelligence systems enable effective analysis of Big Data. Consider, for example, the implementation of AI within an enterprise resource planning (ERP) system, which would allow for better human resource allocation, better financing decisions, more effective production, etc. (Nižetić et al., 2019). A concrete example of this can be seen in the use of AI to increase the effective use of resources or in the collection of data to produce sustainability reports.

## 1.2 ESG factors

Applying a more strictly accounting and financial interpretation to what emerged from the previous paragraph, one can introduce the reasoning by stating, first, that the targets of modern companies have expanded beyond the mere pursuit of profit maximization. Indeed, nowadays, the trend is to disclose information related to the environment, the social sphere and governance as a part of corporate responsibility. This provides a powerful medium through which organizations can communicate their efforts to achieve objectives that are not merely financial. In particular, the concept of sustainability accounting is often used and identified with the activity of analyzing and reporting on the environmental and social impacts of a company (Lamberton, 2005b). The essence of this type of accounting can be explained through the evaluation of its main pillars. To begin with, one of its pillars is clearly non-financial information, as sustainability accounting focuses on aspects such as the impact of a company's actions at the ESG level, which therefore, by definition, clearly goes beyond the monetary level.

One example is the company's own assessment of its impact on areas such as waste management, carbon emissions, labour practices and community engagement. This information is usually disclosed by companies through sustainability reports, which provide transparency to stakeholders, such as investors and customers. Next, in the context of sustainability accounting, ESG factors cannot be overlooked as they affect an organization's risk management and long-term performance. Indeed, the emerging trend of disclosing environmental, social and governance information provides an optimal channel to signal institutions' efforts to achieve these non-financial objectives (Doherty et al., 2023). Specifically, first, the environmental dimension examines how a company affects the environment in terms of waste, biodiversity, water quality, air pollution, carbon emissions and more. Afterwards, the social dimension reflects how a company interacts with its stakeholders and related communities, for example by examining the diversity of its employees, the ways in which it preserves human rights and the ethicality of its supply chain. Next, the governance dimension is defined by a company's strategy, corporate ethics and executive remuneration policies (Amor-Esteban et al., 2018). Therefore, it can be stated that ESG disclosure becomes economically important by improving transparency, investor confidence and capital market integrity, as well as reducing information asymmetry, agency and financing costs, and improving share prices and company value (Dhaliwal et al., 2011; Plumlee et al., 2015).



*Figure 1: ESG Factors*

Finally, the definition of sustainability accounting would not be complete without the inclusion of initiatives such as the Sustainability Accounting Standards Board (SASB), which provides useful guidelines for companies to disclose ESG issues that affect financial stability and value creation. The aforementioned body plays a crucial as well as revolutionary role, as it is a non-profit organization that through the creation of these standards, provides a model for the disclosure of sustainability information relevant to investors. Precisely, in official resources the following definition is given *“SASB Standards help companies disclose relevant sustainability information to their investors. Available for 77 industries, the SASB Standards identify the sustainability-related risks and opportunities most likely to affect an entity’s cash flows, access to finance and cost of capital over the short, medium, or long term and the disclosure topics and metrics that are most likely to be useful to investors”*. (SASB, 2023) In addition, the ISSB<sup>1</sup> had to enhance, keep and upgrade the SASB standards and encourages investors to keep on using them. In essence, therefore, the SASB helps companies clearly and accurately communicate sustainability risks and opportunities, enabling investors to make informed decisions. The standards referred to are sector-specific and help link sustainability to financial reporting.

All in all, then, sustainability accounting helps companies understand and convey their impact beyond financial standards, encouraging responsible business applications and thoughtful decision-making (Patel, 2009).

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<sup>1</sup> International Sustainability Standards Board

With reference to this, it is important to note, that sustainability accounting in management accounting differs from financial accounting in that the former is linked to the definition of new policies and internal decision-making that will have an impact on the organization's Triple Bottom Line, i.e. not only from an economic point of view but also on a business, social and ecological management level. (Perrini and Tencati, 2006). The term 'triple bottom line' was first introduced in the 1990s by the business consultant John Elkington to explain that an investment not only generates financial value, but also economic, environmental and social value. The triple bottom line approach exploits capital more efficiently and effectively, by evaluating the company's activities and resources more carefully (Hammer et al., 2017). An organization can be called 'sustainable' if it manages to generate a balance in all three areas of the triple bottom line and is, therefore, financially stable, while being able to financially, while at the same time managing to contain its negative environmental impacts and meet social expectations (Tenuta, 2009). This practice is often used to trigger value creation within a company and to make it more sustainable. Triple-P accounting and Corporate Sustainability Reporting are the most widely used measurements. These, in the light of financial information, explain the spread of traditional accounting due to improvements in accountability and transparency through reporting on The Triple Bottom Line.

As a consequence of 3TP level reporting, and in order to achieve consistent social and environmental information, frameworks such as the Global Reporting Initiative and Accounting for Sustainability (A4S), aiming at supporting accounting and finance teams in incorporating sustainability into their accounting practices, were created to develop and communicate best practices and global standards to organizations reporting on sustainability.

### 1.3 Definition of 17 SDG of UN 2030 Agenda

During the United Nations Conference on Sustainable Development, Rio+20<sup>2</sup>, which took place in Rio de Janeiro, Brazil in June 2012, the member states initiated a process to develop a set of sustainable development goals (SDGs) that were to be based on the UN Millennium Development Goals (MDGs) of the United Nations, valid up to 2015. The MDGs came into force in 2000 and are eight international development goals that deal with social development issues, with a focus on poverty reduction. The SDGs, compared to the MDGs, take a more holistic approach, broadening the range of goals to capture aspects of the 'triple bottom line' approach to sustainability. In fact, the SDGs address additional issues such as environmental sustainability and economic development, with a focus on inclusive growth. Furthermore, the SDGs, compared to the MDGs, are addressed to all countries and not only to developing countries; indeed they are increasingly concerned with the material aspects of development, consider the role of the private sector in achieving them, and place importance to concrete means for their implementation such as the mobilization of financial resources. (Scheyvens et al., 2016). The SDGs officially entered into force on 1 January 2016.



*Figure 2: Sustainable Development Goals*

The 2030 Agenda adopted by the General Assembly of the United Nations General Assembly consists of 17 Goals, broken down into 169 targets, and 231 unique indicators (OHCHR, 2024)

<sup>2</sup> <https://sustainabledevelopment.un.org/rio20/>



through which each country will be assessed periodically by the UN and public opinion, both nationally and internationally.

Sustainable progress can only be achieved if the Goals are addressed through an integrated approach. In fact, the SDGs propose an integrated vision of policies and the actors responsible for achieving them, which must be able to balance economic growth, social inclusion and respect for the environment and consider therefore, the different dimensions of sustainable development as interconnected dimensions. (Cavalli, 2018).

The Goals of the 2030 Agenda are divided into five key concepts, known as the five P's of sustainable development. The five areas of critical importance are:

- People: Goal 1 to 6.
- Prosperity: Goal 7 to 12.
- Planet: Goal 13 to 15.
- Peace: Goal 16.
- Partnership: Goal 17 (Morton et al., 2017).

The SDGs address all countries and, within them, all members of society, both public and private sector, must strive to contribute to their realization. The actors contributing to the concrete implementation of the SDGs are listed below, with a description of their commitments to them:

- Nations: must fulfil their commitments and create legislation that promote sustainable development.
- The regulators: they must ensure that funding for the SDGs is not to be hindered and include ESG factors within the regulation of the financial system.
- Investors: they must inform themselves about ESG factors as sustainability has become part of their fiduciary duty.
- Companies: they must integrate sustainability within their processes to ensure that their products and services are in line with the SDGs Goals.
- Banks: must assess their portfolios and assets to mitigate risks regarding ESG factors and integrate information on ESG factors into their products and services, informing customers and employees.
- Insurance companies: they must protect their customers from ESG risks.
- The stock exchange and rating agencies: they must establish effective standards for reporting on ESG factors, so that investors have a lot of comparable data.

Accounting professionals: implementing the SDGs requires direct investments in order to build

a physical and institutional structure capable of recalibrate business, financial and governance activities around the SDGs. Accounting skills are fundamental for: meeting the need to have data available on the SDGs, to prepare reports that meet the information needs of the of stakeholders and the financial world, and to design new business models that take advantage of the opportunities offered by the SDGs (Ernst & Young, 2019).

The SDGs are important and useful for several reasons: they represent ambitious goals to make the world a better place, they create a common language to talk about sustainable development and impact investing, they are a framework for sustainable development, they increase the commitment of towards sustainability and are instrumental in creating new sustainable business models sustainable (Rosati and Faria, 2019; Schramade, 2017).

## 1.4 Incorporating the SDGs into corporate reporting

Despite the difficulties concerning the adoption of SDG reporting, many companies have already started reporting on the SDGs. In the absence of a single framework explaining how to report on the SDGs, companies are experimenting with different ways of reporting. In order to remedy the lack of a uniform and single methodology, the GRI, the UN Global Compact and other institutions have prepared several documents, containing different types of information and designed to complement each other, in order to provide companies with a useful body of knowledge for reporting on the SDGs.

One of the documents was published in 2015 by the UN Global Compact, the GRI and the WBCSD<sup>3</sup> and is called the SDG Compass. The document aims to help companies align their strategies to the SDGs and to measure and understand their impacts towards them.

The report 'The Value Driver Model', published in 2014, is a tool created by the UN Global Compact and the Principles for Responsible Investments (PRI). It provides a measurement method to determine and show how corporate sustainability activities contribute to performance company's performance and helps both the company and investors to understand the financial impact of the company's sustainability strategies.

Another useful document for reporting on the SDGs is the report 'An Analysis of Goals and Targets'.<sup>4</sup> The document, published by the Global Reporting Initiative and the United Nations Global Compact in 2017, lists, for each SDG, at the level of the 169 subgoals a range of possible ways of disclosure. The document is particularly important as it represents a step towards the creating a uniform framework that is useful for companies to report on their contribution and impact on the SDGs (Global Reporting Initiative et al., 2018).

Next, in order to show some examples of processes designed to improve SDG reporting, two documents published to help companies to report on the SDGs. The first document is the report 'Integrating the SDGs into corporate reporting: a practical guide'<sup>5</sup> by the Global Reporting Initiative and United Nations Global Compact that suggests a three-step process to incorporate the SDGs into existing business processes and reports. Thus, the process outlined in the report helps companies incorporate the SDGs into their reports. It is based on the principled prioritization process through which a company through which a company identifies the SDGs

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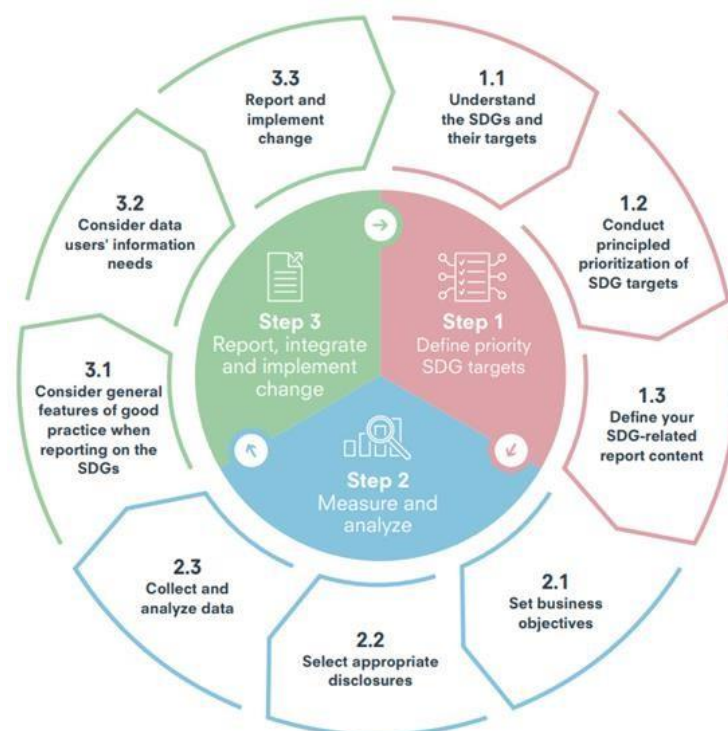
<sup>3</sup> World Business Council for Sustainable Development <https://www.wbcsd.org/>

<sup>4</sup> <https://unglobalcompact.org/library/5361>

<sup>5</sup> [https://sdghelpdesk.unescap.org/sites/default/files/2020-04/GRI\\_UNGC\\_Reporting-%20onSDGs\\_Practical\\_Guide.pdf](https://sdghelpdesk.unescap.org/sites/default/files/2020-04/GRI_UNGC_Reporting-%20onSDGs_Practical_Guide.pdf)

priority objectives to focus on. This process includes considerations regarding:

- risks to people and the environment: the contribution each company can make to achieve the SDGs by taking responsibility for addressing the negative impacts negative impacts on people and the environment generated by its production activities;
- products, services and investments beneficial to the SDGs: the additional contribution that companies can make to achieve the SDGs, thanks to the application of their knowledge, skills and other competencies (GRI, UN Global Compact, 2018).



Fonte: GRI e UN Global Compact, 2018.

*Figure 3: Steps for incorporating the SDGs into corporate processes and reports*

As can be seen from Figure 4, the first step, called 'defining target SDGs priority target SDGs', is useful to understand the process of identifying the priority target SDGs on which the company must act and report on. Prioritization according to the principles is a process through which the choose the SDGs targets to be prioritized, assessing the risks and benefits for people and the environment. The first step is divided into the following three steps:

1.1 Understanding the SDGs and their targets: this consists of studying all the SDGs and their objectives and understand how they relate to the company's business, considering the risks to people and the environment and the beneficial products, services and investments.

1.2 Carry out the prioritization process based on the principles of the target SDGs consists of identifying the priority target SDGs for a company. Two sets of priority target SDGs are formed:

a set of priority target SDGs for the company that have been chosen on the basis of an assessment of risks to people and the environment and a set of priority target SDGs for the company based on the exploration of beneficial products, services or investments.

1.3 Define the content of the SDGs reports: consult with stakeholders in order to find any additional stakeholders in order to find any additional topics of interest to them to include in the report.

The second step, called ‘measure and analyze’, is based on computing and evaluating the results of step 1. In this step, the company’s objectives and strategies must be identified and aligned to contribute to the company’s priority target SDGs. The second step consists of three steps outlined below.

2.1 Establish business objectives: objectives must be defined in order to contribute to the SDG target priorities for the company.

2.2 Select an appropriate reporting method: you must identify suitable.

2.2 Select an appropriate reporting method: you need to identify suitable indicators to measure progress on the goals you have set to contribute to the priority target SDGs.

2.3 Collecting and analyzing data: after having selected indicators to measure and objectives, data must be identified and collected regularly for each indicator, both quantitative and qualitative indicator, both quantitative and qualitative.

The third step is called “reporting, integrating and implementing change”. It offers advice and guidance on SDG reporting. Based on the results of the second step, the third step illustrates the steps needed to unite the content of the report, which is addressed to actors outside the company and reflect internally on the implementation of change. The third step consists of three steps illustrated below.

3.1 Consider the general characteristics of good practice when preparing the report: this step lists some recommendations that the company should follow while preparing the SDG reporting.

3.2 Consider the information readers need: SDG reporting should provide shareholders and other stakeholders, such as investors, civil society, consumers, and academia, with information they need. consumers and academia, with information useful for their decisions. Therefore, one must constantly ensure that one has met their information needs.

3.2 Reporting and implementation of change: so that any gaps between current and expected performance can be anticipated, reflected on improvements, and expected performance, reflect on improvements, and include this information in reports.

In order to achieve the objectives effectively, it is important to have good internal coordination and a good distribution of responsibilities.

The second document to be discussed in this section is the report 'How to report on the SDGs', published in 2018 by KPMG. The report lists nine guidelines through which users of SDG reporting can ensure that they have done good reporting. Thus, the report does not describe a standard to be used for reporting on the SDGs but offers guidelines useful for evaluating and comparing the quality of SDG reporting of large companies. The report lists 9 criteria divided into three themes. The following figure represents these criteria.



Figure 4: The 9 qualitative criteria for SDG reporting

The three main themes are: understand, prioritize and measure and are composed of three criteria each.

In addition, the GRI has developed several tools and initiatives with the aim of assisting companies in measuring and achieving the SDGs. One tool developed, for example, is 'the Business reporting on the SDGs resources', created in collaboration with the UN Global Compact. The purpose of the initiative is to help institutions incorporate SDG reporting into their existing processes to promote the achievement of the SDGs goals (United Nations Global Compact, 2018; Rosati and Faria, 2019). Besides, the GRI published a new document on its website in 2020, which replaced the previous 2016 version, called: 'Linking the SDGs and the GRI Standards' with the aim of helping societies to incorporate their progress regarding the SDGs into their reports. The document lists all 17 UN Goals and links them to the 27 GRI Standards and the disclosures applicable to each. The document explains how to use the GRIs to assess a company's impact on the SDGs, making it easier to include the SDGs in reports. The

document contains a table where the SDGs, broken down into the 169 sub-goals, the available methods of Disclosure according to the GRI Standards for each sub-goal, the unit of measurement and the relevant source are included.

Next, the context Integrated Report should be mentioned. It is defined by the IIRC<sup>6</sup>, as a short communication that explains how the strategy, governance, performance, and prospects of an organization enables it to create value in the short, medium and long term in the context in which it operates (IIRC, 2013). It proposes a reporting model that appears suitable to complement the SDGs and contribute to their pursuit (Adams, 2017). The UN Conference on Trade and Development (UNCTAD) and the IIRC have established a collaboration to guide companies in reporting their performance in terms of sustainability. UNCTAD is an institution that addresses the accounting issues of the United Nations member countries and has helped countries develop a robust system of corporate reporting to facilitate investment. The two societies have established a collaboration to achieve goal 12.6 of the SDGs, working together to integrate the SDGs into corporate reporting. The objective of SDG 12 is to ensure 'sustainable production and consumption patterns' and, particularly, Target 12.6 calls for: "encourage companies to adopt sustainable practices and integrate sustainability information into their regular reporting". Thus, the integrated reporting framework helps companies seeking to achieve Target 12.6, by being a report that integrates information on sustainability. The function of the integrated reporting is not only to achieve target 12, but also to encourage companies to align their value creation models with the SDGs<sup>15</sup> (Unctad, 2019).

The integrated reporting framework is suitable for integrating the SDGs, as its structure is based on the multi-capital model that takes into account, for example, natural and human, two important values for sustainability. In addition, the framework shows the history of value creation of an institution and explains which sustainable development inputs influence the value created. The following figure shows the connection between the six capitals and the 17 Sustainable Development Goals.

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<sup>6</sup> International Integrated Reporting Council (IIRC)

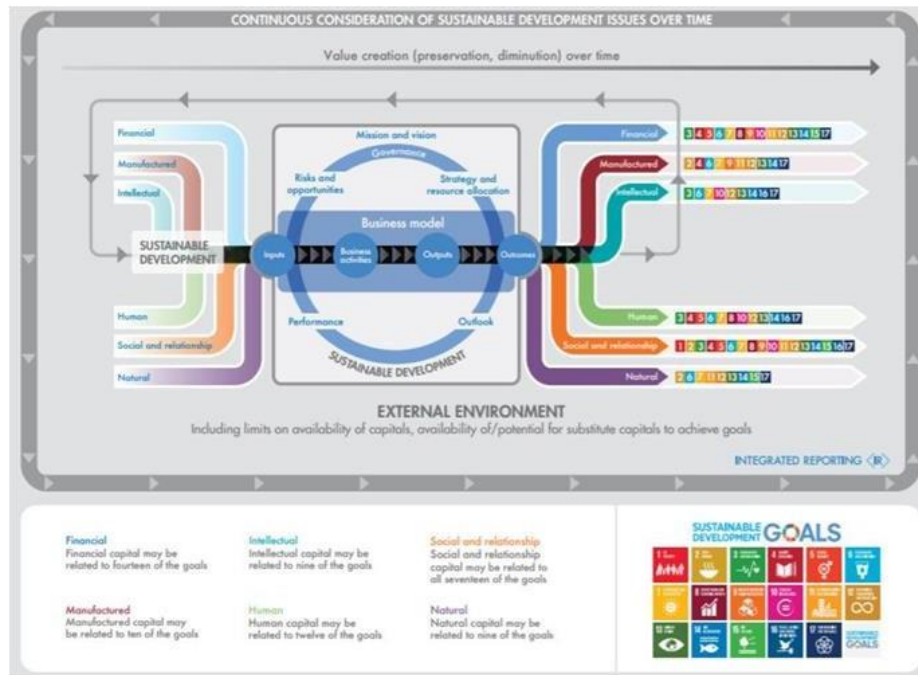


Figure 5: The connection between the IR Framework and the SDGs

### 1.5 Sustainability Reporting and Sustainability Management Control Systems

Sustainability Reporting represents one of the main communication tools for organizations wishing to report relevant information on sustainability. It is generally based on GRI standards and aims at providing key information on environmental, social, and economic aspects of the company. Companies that prepare a sustainability report measure the impact of their strategic moves on the environment and people also on the basis of the guidelines provided by ESG criteria, i.e. environmental, social and governance sustainability. On a structural level, a sustainability report should start with a management statement, expressing the company's commitment to sustainable practices. After that, there will be a description of the organization and its operating context. In this context, there must be, economic balance, which from the point of view of corporate sustainability, means that the value created by the company, relative to revenues and positive externalities, is greater than the value consumed, i.e. relative to costs and negative externalities. Finally, the four dimensions of the sustainability report (environmental, social, governance and economic) must be managed organically, and the potential risks associated with them must be foreseen.

Thus, sustainability reporting is a corporate practice of publicly reporting its economic,



environmental, and social impacts and its contributions towards sustainable development. Sustainability reporting helps internal and external stakeholders to make informed decisions and be aware of how the company approaches sustainable development (GRI, 2016).

The real reasons why companies choose to draw up a sustainability report and disclose information regarding social responsibility is still not clear. Some researchers state that the objective is often the improvement of the corporate image and not a real desire to be accountable to stakeholders and to and to present them with more information (Durden, 2008). The possible advantages of reporting information regarding sustainability mostly related to its external function, can be traced back to:

- Legitimization of its business activities, products and services that create.
- Environmental and social impacts.
- Enhancement of image, reputation and brand value.
- Gaining a competitive advantage.
- Signal increased competitiveness, using reporting of sustainability as an indirect measure of overall performance.
- Comparing and benchmarking with competitors.
- Increasing transparency and accountability within the company:
- Stabilization and support of employee motivation (Herzig and Schaltegger, 2006).

Sustainability performance reporting, in addition to its external function can also have the internal function of helping the company to measure its sustainability performance and to develop its own sustainability performance measurement systems that are specific to the company's business.

Sustainability reports can be consulted by companies to understand their own strengths and weaknesses and to identify possible interdependencies within them. (Oncioiu et al., 2020).

The obligation for a company to present a sustainability report depends on its location.

In Europe, for example, some institutions have a regulatory obligation regarding sustainable and ESG investments. Consider the Corporate Sustainability Reporting Directive (CSRD), an EU regulation that requires companies to report on the environmental and sustainable impact of their business activities, as well as their ESG initiatives.

Several resources exist to guide companies through the reporting process. For starters, companies can refer to the Sustainable Development Goals, which serve as a guiding framework for both governments and organizations. Introduced by the United Nations, the SDGs set a

global agenda for sustainable development with the hope of achieving a more sustainable future by 2030. From there, companies can turn to various third-party organizations that set standards for sustainability reporting and can help companies find the right sustainability reporting framework to use:

- The Sustainability Accounting Standards Board (SASB) which is a non-profit institution that establishes industry-specific standards to help guide the disclosure of sustainability information, such as greenhouse gas emissions, to investors and other financial stakeholders.
- The International Sustainability Standards Board (ISSB) that is an independent standards body which wants to create a comprehensive global base of high-quality sustainability disclosure standards to meet the needs of investors and financial markets.
- The Global Reporting Initiative (GRI) which is a non-profit organization that provides a globally applicable guiding framework for a comprehensive range of ESG and sustainability issues. Today, GRI standards provide a basic guideline and roadmap for companies to set goals and create their own sustainability reports. (IBM, n.d.)

Therefore, from what has emerged so far, it can be said that the concept of the sustainability report is accompanied by the 'Sustainability Management Control Systems' (MCS), i.e. the set of mechanisms that influence the behaviour of managers and employees to achieve the companies' objectives and strategies, the most representative examples of which are the 'Sustainable Balanced Scorecard' (SBSC) and the 'Key Performance Indicators' (KPIs).

Malmi and Brown argued that MCSs are *"a package of systems, rules, practices, and values; that is, all the mechanisms that managers use to ensure that the conduct and decisions of employees are consistent with the objectives of the organization (strategic or operational). So, they go beyond information for decision-making."* Besides, it's interesting to note that, according to them, *"the strength of the typology lies in the broad scope of the controls in the MCS as a package, rather than the depth of its discussion of individual systems"* (Malmi & Brown, 2008). In particular, there are five types of controls: reward, planning, cybernetic and compensation, administrative, and cultural controls."

The Sustainability Balanced Scorecard is basically an extension of the ordinary Balanced Scorecard, which consists of a tool for balancing the various ways of measuring the success of a company by harmonizing the different types of performance, be they financial or non-financial, short-term or long-term, qualitative or quantitative with the needs of customers and owners, who are hierarchically placed in the main performance perspectives (Kaplan & Norton, 1992; 1996; 2001).

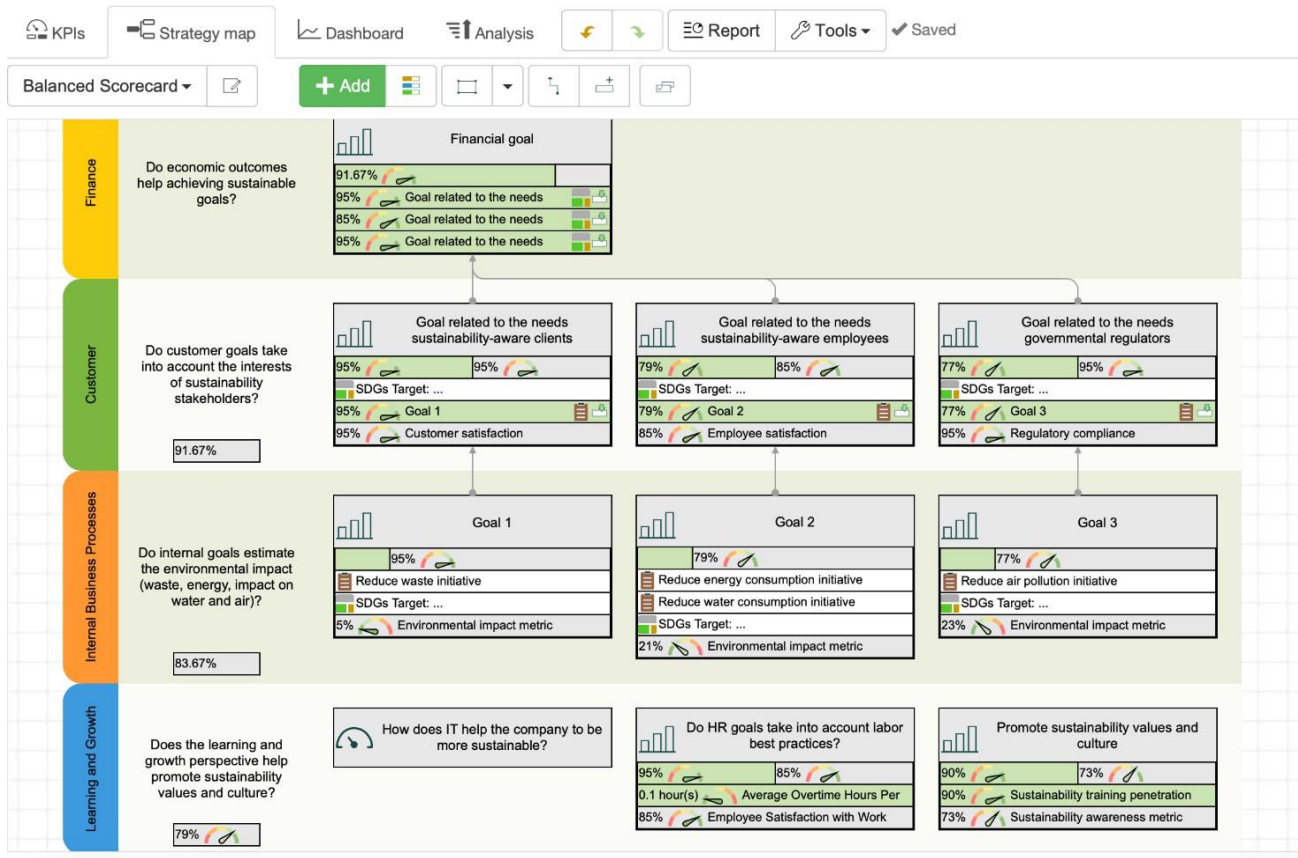


Figure 6: Sustainability Balance Scorecard

In its original form the BSC was developed by Kaplan and Norton (1992, 1996) to reduce problems deriving from the extended use of financial results control systems and accounting measures, such as transaction-based orientation, focus on the past, lack of congruence with changes in firm value and short-termism, which can cause topic decision-making. Its approach to performance measurements is multi-dimensional. This means, that it integrates the traditional financial performance measures as *the outcome measures a firm success with metrics from three additional perspectives- customer, internal process and learning and growth- based on cause-and-effect relationships and regarded as the drivers for creating long-term shareholder value* (Mio et al., 2022).

Therefore, the concept of SBSC come from the traditional BSC combining the four perspectives of the BSC with sustainability to embed ESG concerns explicitly and involving performance measures and sustainability-related objectives. The SBSC may be an extremely interesting tool to satisfy a range of sustainability management needs, specifically, to support companies in the process of foster sustainability management standards, implementation of a sustainable strategy, decision-making and reporting, support regulatory data requirements, make

employees more sensitive to sustainability issues and meet stakeholders' information demands (Epstein & Wisner, 2001). Initially proposed as a performance measurement tool, the BSC has become increasingly associated with strategic planning and implementation, serving as a management framework that helps identify the critical value drivers that businesses could exploit to optimise strategy (Kaplan & Norton, 2001). Under the BSC approach, top management translates its strategy and vision into a set of performance measures that employees can understand and act on, according to the four perspectives. It could be defined as a system that combines financial and operational measures with a series of sustainability-related objectives, such as the reduction of environmental impact and social welfare, in order to obtain a more comprehensive overview of corporate performance. The correct preparation of a SBSC, allows the definition of the activities to be put in place, following an accurate analysis, to outline the company's objectives, both from an economic-financial perspective and at the level of environmental and social impacts of sustainability. This process ends with the analysis of performance indicators, which verify whether the objectives set in the budget have been correctly achieved and pursued, as well as to take corrective action if this is not the case. In this specific context, the main KPIs used naturally concern the economic, environmental and social spheres. The former includes indicators of economic success, e.g. operating profit or EBITDA, indicators of the determinants of this economic success, e.g. degree of innovation or resource consumption, etc., and indicators of a non-financial character, such as customer satisfaction. With specific reference to GRI at the level of sustainable economic performance indicators, these refer not only to the classical ones, but also to additional indicators that consider impacts beyond the company boundaries such as improving public health and reducing unemployment (GRI, n.d.).

Next, there are the numerous KPIs related to the environmental performance of companies. Forbes describes Key Performance Indicator (KPI) as a quantifiable metric used to assess individual or organizational performance in achieving specific objectives. By reviewing and evaluating KPIs, businesses can determine whether they are making progress toward their desired goals. These indicators cover various aspects such as profits, employee turnover and average annual expenses. Regularly analyzing KPIs provides a comprehensive overview of a business's performance, enabling decision-makers to assess whether current strategies should be maintained or if adjustments are necessary (Hennigan, 2023). KPI can likewise be divided into the three main classifications of: Operational Performance Indicators (OPIs), which focus on inputs such as materials, water and energy; Management Performance Indicators (MPIs), which retrieve information and data on activities such as corporate policy structuring or the degree of compliance with regulations; and Environmental Performance Indicators (EPIs),

which focus, for example, on the damage caused by certain types of emissions or concentrations of pollutants in certain areas.

Finally, social performance indicators, which have been developed and adopted very recently by companies, mainly concern aspects of labour practices, human rights, society, and product responsibility.

## 1.6 Regulatory Framework

At the regulatory level, the international environment of sustainability reporting is characterized by intense complexity and data management has proven to be so complex that it requires the use of advanced tools. Furthermore, the environmental, financial and social contexts have been increasingly rethought in their foundations and this has exacerbated the need to achieve levels of analysis that previously seemed unattainable. Added to this is the fact that macroeconomic phenomena and the complications that have emerged during recent crises (such as, for example, the Covid-19 pandemic) have brought a heightened awareness of the need for a more careful and in-depth management of the dissemination of sensitive data. Issues such as capital flows, investments, environmental and social sustainability, and information transparency have never been more important than in recent years (Macpherson et al., 2021). This complexity has generated intense uncertainty, caused by the mixture of adverse events and the increase in laws and empirical evidence that have promoted this increased focus on data. In particular, this new situation can be described as transformative, as the attention that companies have to devote to the new dimensions of information management causes a sometimes-substantial change in production processes and even products. In addition, consumer expectations also have a particularly strong influence on the strategies of companies, which, in order to maintain their competitive position, must use increasingly sophisticated technologies to demonstrate their sustainability. The general promotion of sustainability does not only come from the market but is also prompted by a complex set of personalities and institutions, such as universities and governments, which set up very strong constraints that companies have to submit to in order to be able to strategically position themselves in the market. This implies the need to govern data reaching the enterprise from ever new sources and with ever increasing levels of complexity (Macpherson et al., 2021).

Today, for companies, the value of interaction with key stakeholders is increasingly relevant, which is why they tend to emphasize the importance of internal organizational communication and the need to facilitate the dissemination of appropriate content to meet the information

needs of the growing number of target groups. (Bisio, 2015, p. 3). The main risk of a company starting to communicate sustainability is to run into greenwashing, which refers to the set of all those practices that tend to capitalize on the benefits of a business approach based on sustainability, diverting attention from its 'unethical' or 'not properly aligned with sustainability principles' (Siano, 2014, p. 134). To achieve this, and to avoid falling into mere marketing and greenwashing itself, the company must be able to produce clear, accurate, measurable, and comparable data. Indeed, the noblest objective of any sustainability communication is to identify content and communication channels as useful tools for shaping culture, disseminating values and new sustainable lifestyles and consumption.

In recent years, a practice that is becoming increasingly relevant for companies of all sizes, including small and medium-sized enterprises (SMEs), is ESG reporting, which consists of the dissemination of information on a company's social responsibility, corporate governance, and environmental impact. This report, due to its quantitative and analytical dimension, but also to its content and creativity, is both a management and communication tool, useful for all stakeholders to know the company's sustainability performance in terms of strategies, tools, results, projects, and future objectives. Indeed, sustainability reporting is defined as that process through which a company communicates projects and results achieved in terms of economic, environmental, and social sustainability. Such reporting flanks and complements traditional financial reporting to also include the impact that the institution has on the areas just mentioned, in compliance with the regulations on non-financial reporting, that is mainly the Non-Financial Reporting Directive (NFRD) and partially the Corporate Sustainability Reporting Directive (CSRD), and in the direction of the principles of double materiality.

### 1.6.1 Double Materiality

The new European Corporate Sustainability Reporting Directive (CSRD) requires subject companies to report on ESG issues according to the principle of ‘double materiality’. This concept is already present in key regulations such as the European Sustainability Reporting Standards (ESRS) and the guidelines of the Global Reporting Initiative (GRI) and obliges subject companies to report ‘both on the impact of the company’s activities on people and the environment, and on how sustainability issues affect the company’. Specifically, the definition provided by the ESRS is as follows: *Double materiality is a concept which provides criteria for determination of whether a sustainability topic or information has to be included in the undertaking’s sustainability report. Double materiality is the union (in mathematical terms, i.e. union of two sets, not intersection) of impact materiality and financial materiality. A sustainability topic or information meets therefore the criteria of double materiality if it is material from the impact perspective or from the financial perspective or from both of these two perspectives.*” (ESRS 1, EFRAG 2023)

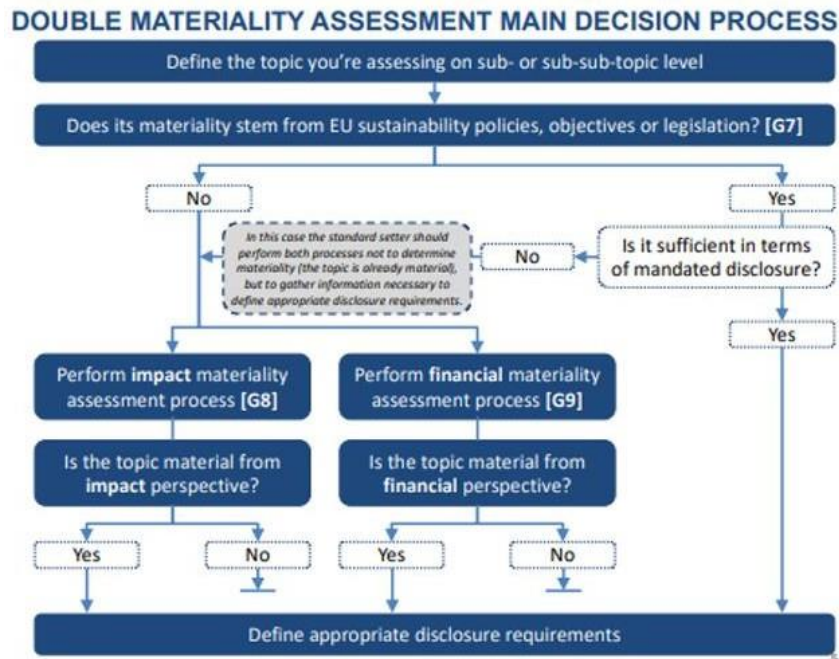


Figure 7: Double Materiality main decision process

From this definition, it can be seen that there are essentially two types of materiality that offer diametrically opposed points of view.

The first, defined as ‘impact materiality’ offers an ‘inside-out’ perspective, giving a view of the impacts, positive and negative, actual and potential, that the organization can generate

externally, such as towards the economy, or towards people or the environment. It might be interesting to compare definitions of the same, so as to grasp any differences and similarities. In the context of the GRI standards, the following is stated: *“Materiality in the context of the GRI refers to sustainability issues that are relevant to stakeholders and that can influence the assessments and stakeholder decisions. The materiality depends on the stakeholder perception of the relevance of the issues for the company and its stakeholders, as well as on the impact of the issues on the company’s ability to maintain, create or destroy economic, environmental, and social value in the short medium and long term’.* (GRI 101-1)

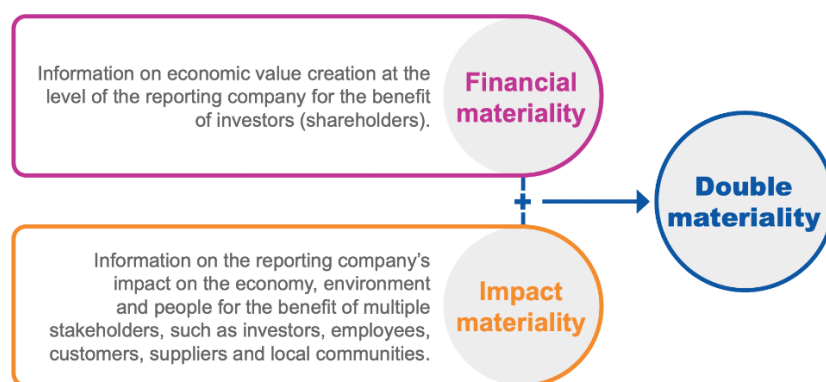


Figure 8: Representation of the concept of materiality in GRI context

Consequently, it is evident that the GRI standards therefore place a strong emphasis on sustainability impact, focusing on how an organizations’ activities affect the outside world. Its definition of materiality includes environmental, social, and economic aspects.

The ESRS standards, on the other hand, offer the following definition: *‘Impact materiality is a characteristic of a sustainability topic or information in relation to an undertaking, in a particular sector or in all sectors. A sustainability topic or information is material from an impact perspective if the undertaking is connected to actual or potential significant impacts on people or the environment and is related to the sustainability topic over the short, medium, or long term. This includes impacts directly caused or contributed to by the undertaking and impacts which are otherwise directly linked to the undertaking’s upstream and downstream value chain’.* (ESRS European Sustainability Reporting Guidelines, 2022).

In general, the significance of current negative impacts is assessed on the basis of the severity of the impact, while that of potential negative impacts is based on both severity and likelihood of the impact. In turn, severity is then classified according to scale, magnitude, and



irretrievability. Furthermore, if an adverse impact leads to a violation of human rights or fundamental labour rights, or if it leads to non-compliance with greenhouse gas (GHG) emission reduction targets set by the United Nations Framework Convention on Climate Change, the scale of the impact can be considered significant. (European Central Bank, 2022). On the other hand, with regard to positive impacts, materiality is essentially based on magnitude and scope. (effediligence.co.uk)

Impact materiality is already well known by companies that, in order to keep up with the Non-Financial Directive, the directive that preceded CSRD, have adopted the reporting standards proposed by the Global Reporting Initiative, which are actually the most widespread globally and are based precisely on the materiality of impact as the driver of corporate sustainability reporting.

The need for greater clarity and transparency has prompted the European Union and the EFRAG (European Financial Reporting Advisory Group), the body responsible for drawing up the mandatory reporting parameters for companies that will be subject to CSRD, to integrate the concept of impact materiality with that of 'financial materiality': the latter offers a perspective that is instead defined in the standards as 'outside-in' and is therefore opposite to the former, since it considers in reporting the external sustainability aspects, i.e. potential risks and opportunities, economically relevant to the company, i.e. such as to influence its economic value potentially affecting the company's development, its balance sheet, its cash flows or its economic result.

ESRS describes it as follows: *“Financial materiality in the context of sustainability reporting is a characteristic of a sustainability topic or information in relation to an undertaking, a particular sector or all sectors. A sustainability topic is material from a financial perspective if it triggers financial effects on undertakings, i.e. generates risks or opportunities that influence or are likely to influence the future cash flows and therefore the enterprise value of the undertaking in the short, medium or long term but are not captured by financial reporting at the reporting date. These risks and opportunities may derive from past events or future events and may have effects on future cash flows in relation (i) to assets and liabilities already recognized in financial reporting or that may be recognized as a result of future events or (ii) to factors of enterprise value creation that do not meet the accounting definition of assets (liabilities) and/or the related recognition criteria but contribute to the creation/maintenance of enterprise value. The latter are generally defined as « capitals » in frameworks promoting a multi-capital approach”.* (ESRS - European Sustainability Reporting Guidelines).

Essentially, therefore, financial impacts can be divided between those concerning the ability to maintain or acquire resources, i.e. concerning an entity's ability to maintain or acquire the resources necessary for its production cycle, and relationship reliability, i.e. concerning an entity's ability to rely on relationships necessary for its operational processes.

Basically, financial materiality in the context of sustainability reporting was introduced to provide additional support in the process of determining the information to be included in the sustainability report. In general, this information is relevant for the main users of the financial statements, as its omission or incorrect compilation could reasonably influence decisions based on the company's sustainability report.

Since the assessment of impact-related materiality and financial materiality are closely linked, therefore, both impact-related and financial materiality must be given equal importance. In any case, beyond the actual and potential financial consequences resulting from material impacts, it is crucial that the organization reflects on how it is affected by sustainability issues external to its activities (Petrini, 2023).

In addition, it is interesting to notice that not everyone agrees that companies should consider both financial and impact materiality. While some standards focus primarily on financial materiality, others promote the importance of also considering impacts. Some sustainability reporting standards place more emphasis on financial materiality, while others focus on the materiality of impacts. The TCFD<sup>7</sup> and SASB generally take an external perspective, assessing how environmental, social and governance (ESG) issues affect a firm.

While it could be argued that GRIs focus primarily on the environmental, social and governance impacts caused by the company, the Corporate Sustainability Reporting Directive (CSRD) also places great importance on the materiality of impact but considers it on the same level as financial materiality. It therefore remains the only corporate reporting standard that explicitly incorporates dual materiality in its reporting directive for companies. The intent of CSRD is to allow investors and third parties to assess the contribution of companies to a fair and sustainable economic system.

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<sup>7</sup> Task Force on Climate-related Financial Disclosures

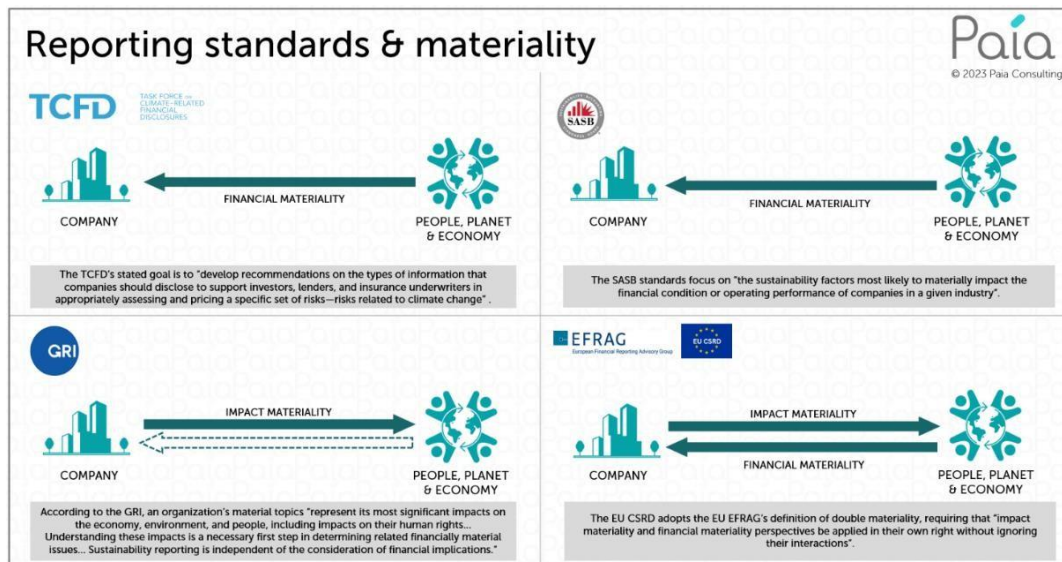


Figure 9: Reporting Standards and Materiality

Double materiality is therefore a fundamental principle for companies following a sustainability strategy. These organizations not only protect their corporate value from ESG risks, but also actively work to reduce the negative impact on the environment and society. This approach has become increasingly relevant as sustainable investments grow and investors pay attention not only to the financial performance of the companies they invest in, but also to their overall impact on the environment and society.

### 1.6.2 NFRD E CSRD: Sustainability Reporting Legislation in EU

The new Corporate Sustainability Reporting Directive (CSRD) is intended to replace the obligations introduced into European accounting law by the Non-Financial Reporting Directive 2014/95/EU, better known as the Non-Financial Reporting Directive (NFRD). As of 2018, the Non-Financial Reporting Directive obliged large companies to report annually on the non-financial aspects of their activities. These aspects include environmental, social, personnel-related, human rights, and active and passive corruption issues. Companies that fall under the scope of the NFRD are those that constitute public interest entities and have an average number of employees during the financial year of 500 at the balance sheet date. In the years preceding the implementation of the directive, the use of NFRD frameworks steadily increased (KPMG, 2020).

## EU Non-Financial Reporting Directive (NFRD) reporting

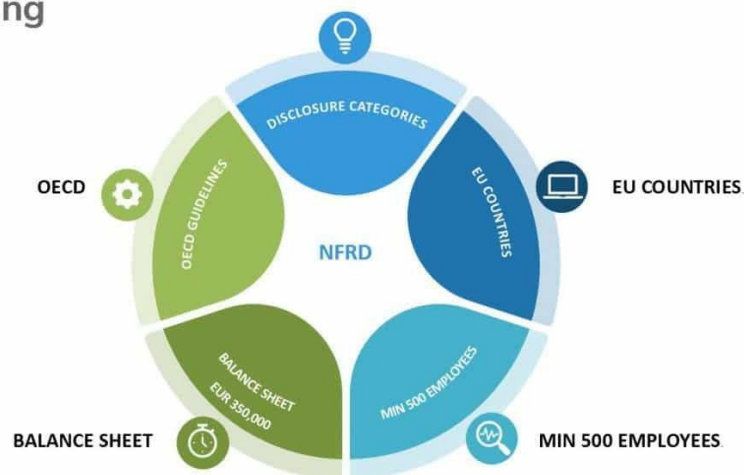


Figure 10: EU Non- Financial Reporting Directive scheme (NFRD)

In the course of 2019, with the aim of covering gaps in sustainability reporting, additional disclosures on the disclosure of non-financial information, mainly regarding climate, were published, but with little success. The revision aimed to address the problems of reliability and comparability, but the new provisions neither enabled the disclosure of higher quality information nor improved the effectiveness of NFRD (European Commission, Directive of the European Parliament and of the Council, 2021). These shortcomings, together with the fact that sustainability disclosure practices were not able to meet the growing demand for data and information from investors, led to a loss of credibility, which mainly caused three problems involving all stakeholders, from the companies themselves to the stakeholders:

- Firstly, investors did not have a reliable overview of the sustainability risks to which companies are exposed.
- Secondly, reliable, and high-quality public reporting by companies was not guaranteed.
- Finally, due to the lack of precision in the current provisions and the existence of a large number of private frameworks and principles, it became difficult for companies to know exactly what information to disclose (European Commission, 2021).

It was evident, therefore, that there was a need to broaden the quality of reporting by proposing an assessment of the NFRD highlighting the fact that inconsistencies were present, both in terms of horizontal alignment, i.e. inconsistent requirements for a given data processor, and vertical alignment, i.e. data results from data generators not aligned with the reporting requirements of data users. (EFRAG, European Sustainability Reporting Standard E1, 2022).

Without any doubt, one of the most significant limitations of the NFRD is the inaccuracy of the concept of double materiality, introduced by the directive itself and which European companies struggle to understand or otherwise translate into practice. In fact, this principle, in the NFRD context, was aimed directly at the recipients of the reports, such as producers, consumers, and stakeholders in general, who wanted to know the impact on the economy, the environment and society, so that they could identify relevant behaviour that could lead companies to improve their sustainability strategies. To do this, companies initially relied on interviews, surveys, or workshops with stakeholder groups to understand what information was actually “material” and relevant to them.

Unfortunately, however, this approach is difficult to apply if the identification of stakeholders is unclear and the process itself could lead to a misidentification of material issues (Bossut and ot., 2021). Under these circumstances, the principle of dual materiality was not properly exploited. The latter, in fact, should have served as an important operational tool enabling companies and stakeholders to obtain a good perspective, internally and externally, of ESG impacts. To achieve better and more fit-for-purpose results, the guidelines in the NFRD were updated with the new CSRD standard setter, which Baumüller & Stefan define as follows: “*The CSRD represents one further step towards more explicit and extensive reporting requirements with regard to sustainability matters.*” (Baumüller & Stefan, 2021).

On the other hand, in order to improve corporate sustainability reporting, on 21 April 2021, the European Commission introduced the Corporate Sustainability Directive (CSRD).



Figure 11: Proposal for Corporate Sustainability Reporting Directive

The concept of '*non-financial reporting*', used in the previous regulation, has been replaced with that of '*sustainability reporting*', thus amending the previous regulation 2014/95 on minimum reporting standards in environmental and social matters, in relation to personnel management, respect for human rights and anti-corruption.

The main objective of the directive is to strengthen sustainability reporting by allocating itself, on a regulatory level, together with the EU Taxonomy<sup>8</sup>, which defines the criteria for considering an economic activity as sustainable, and the Sustainability Finance Disclosure Regulation (SFDR)<sup>9</sup>, which obliges financial market participants to provide information on how they integrate ESG factors into their investment strategies according to the products offered to the public (Accountancy, 2021). The CSRD thus also deals with non-financial reporting and extends the scope and reporting requirements of the NFRD (Non-Financial Reporting Directive).

In particular, by means of Regulation (EU) 2023/2772 of 31 July 2023 (EU Law - EUR-Lex, n.d.), published in the Official Journal of the EU by the European Commission, the adoption of the first set of European Sustainability Reporting Standards (ESRS) envisaged by the Corporate Sustainability Reporting Directive (CSRD) 2022/2464 was sanctioned. Specifically, some of the key points of the Directive concern the broadening of the scope of those required to draw up sustainability reports (about more than 50,000 companies throughout Europe and 5,000 in Italy); a more detailed and well-structured information set for sustainable reporting; and an update of existing regulations, including Directive 2013/34/EU concerning the reporting of non-financial data.

This update is part of the European Green Deal<sup>10</sup>, which aims to transform the Union into a modern, resource-efficient and competitive economy with a net greenhouse gas emission target by 2050 (European Parliament, European Council, 2022). Consequently, this document not only has a scrupulous legal value, but above all represents a guide for the economic development of companies at national, EU and international level. Indeed, the issue of sustainability is

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<sup>8</sup> The EU taxonomy is a cornerstone of the EU's sustainable finance framework and an important market transparency tool. It helps direct investments to the economic activities most needed for the transition, in line with the European Green Deal objectives. [https://finance.ec.europa.eu/sustainable-finance/tools-and-standards/eu-taxonomy-sustainable-activities\\_en](https://finance.ec.europa.eu/sustainable-finance/tools-and-standards/eu-taxonomy-sustainable-activities_en)

<sup>9</sup> The Sustainable Finance Disclosure Regulation (SFDR) set out how financial market participants have to disclose sustainability information and helps those investors who seek to put their money into companies and projects supporting sustainability objectives to make informed choices. [https://finance.ec.europa.eu/sustainable-finance/disclosures/sustainability-related-disclosure-financial-services-sector\\_en](https://finance.ec.europa.eu/sustainable-finance/disclosures/sustainability-related-disclosure-financial-services-sector_en)

<sup>10</sup> To overcome the challenges of Climate change and environmental degradation in Europe and the world, the European Green Deal will transform the EU into a modern, resource-efficient and competitive economy, ensuring no net emissions of greenhouse gases by 2050, economic growth decoupled from resource use and no person, and no place left behind. The European Commission has adopted a set of proposals to make the EU's climate, energy, transport and taxation policies fit for reducing net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels. [https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal\\_en](https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en).

fundamental for receiving European funds for business development, with the now well-known Digitalization (European Parliament, n.d.)

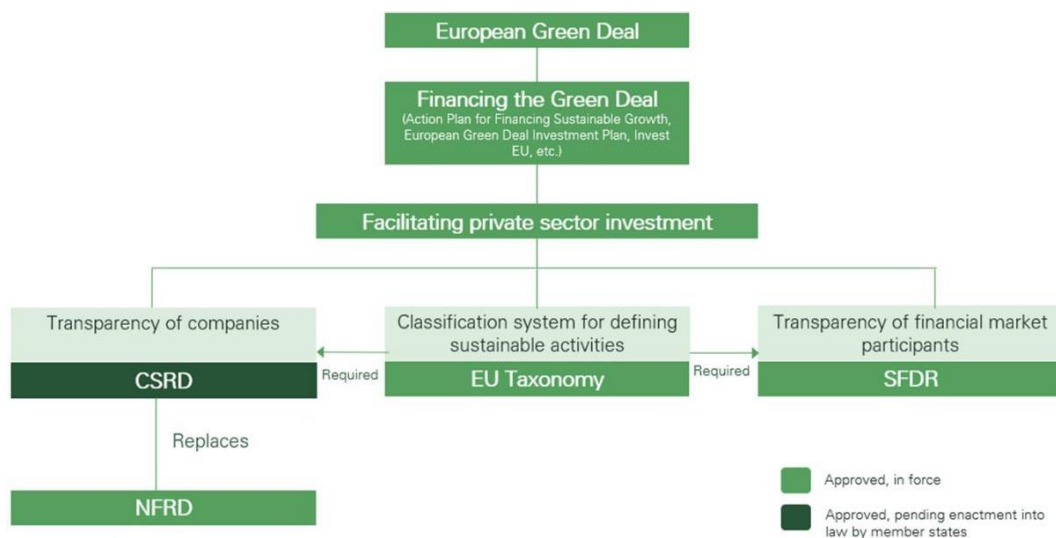


Figure 12: Representation of EU CSRD ESG regulation

It should be noted, that since, when discussing reporting, reference is made not only to ESG (Environmental, Social, Governance) factors, but also to other intangible factors such as human capital, relationships and benefits, in order to accurately assess the level of sustainability of organizations and their ability to find sustainable solutions, all these aspects should be analyzed in depth in the report.

In this regard, the Corporate Sustainability Reporting Directive represents a significant shift in sustainability reporting practices, emphasizing the importance of transparency and greater comparability in reporting on sustainability issues. This is in line with global trends that incorporate ESG considerations into corporate practices and refers to the ESRS (European Sustainability Reporting Standards) developed by EFRAG (European Financial Reporting Advisory Group) and aligned with GRI (Global Reporting Initiative).'

The new rules and the timeline for implementation will be staggered according to company size, between 2024 and 2028:

- First of all, large public interest companies with more than 500 employees, which are already subject to the NFRD, will have to start publishing their data from 1 January 2024 with the report to be published in 2025.
- After that, large companies that are not yet subject to the NFRD but have more than 250 employees and/or EUR 40 million in turnover and/or EUR 20 million in total assets, will

have to start applying the rules as of 1 January 2025 with the report to be published in 2026.

- In addition, SMEs and other listed companies (with the exception of micro-enterprises) with at least two of the following characteristics: 10 - 250 average number of employees; €700,000 - €40mln net revenue; €350,000 - €20mln balance sheet, will have time from 2026 until 2027 to publish them. Since SMEs listed on regulated markets in the Union constitute a significant share of the companies with securities participating in trading on regulated markets in the Union, it should be provided that they also disclose information on sustainability issues in order to protect investors and enable them to obtain all the information they need to be able to fulfil their obligations under Regulation (EU) 2019/2088 ('Disclosure' or 'SFDR') (Prisco, 2024)
- Finally, as of 2029, the Corporate Sustainability Reporting Directive (CSRD) also imposes new rules for corporate sustainability reporting. Specifically, a parent company resident in non-EU countries will be subject to the CSRD if the parent company has net revenues exceeding €150 million or at least one subsidiary meeting the size requirements of the CSRD or one with net revenues exceeding €40 million in the previous financial year. (Directive - 2022/2464 - EN - CSRD Directive - EUR-LEX, n.d.-b)

Member States had to transpose the directive by 6 July 2024. The consultation regarding this process was managed by the Treasury Department and contributions should have been sent no later than 18 March 2024 (PricewaterhouseCoopers, 2024). The sustainability reporting produced by companies must contain all disclosures required by the ESRS and must be in the European electronic reporting format (EU Delegated Regulation 2019/815). The entry into force of the CSRD means that a '*statement of compliance of sustainability reporting*' must be drawn up for sustainability reporting in order to obtain '*limited assurance*' on the content, and that the reporting obligations have a scope that, unlike the NFRD, includes the business model of companies, requiring data such as a brief description of the company's business model and strategy or information on the existence of incentive systems related to sustainability issues. Furthermore, according to the requirements of the Green Taxonomy, organizations subjected to the obligation to publish non-financial information must also report data relating to economic activities aligned and not to the EU Taxonomy (so-called Taxonomy alignment<sup>11</sup>) (Prisco, 2024b).

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<sup>11</sup> The EU Taxonomy came into force on 12 July 2020 and companies will have to disclose their taxonomy alignment on three KPIs (CAPEX, OPEX and turnover) as of 2022 over 2021. The Taxonomy Regulation offers a classification system for companies and investors to determine whether an economic activity is "green" or not. [KPMG EU Taxonomy Quick Guide.pdf](#)



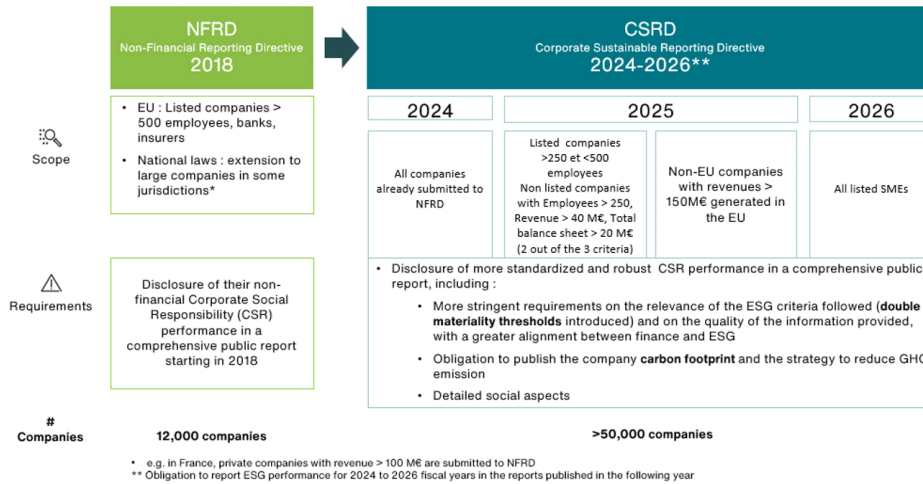
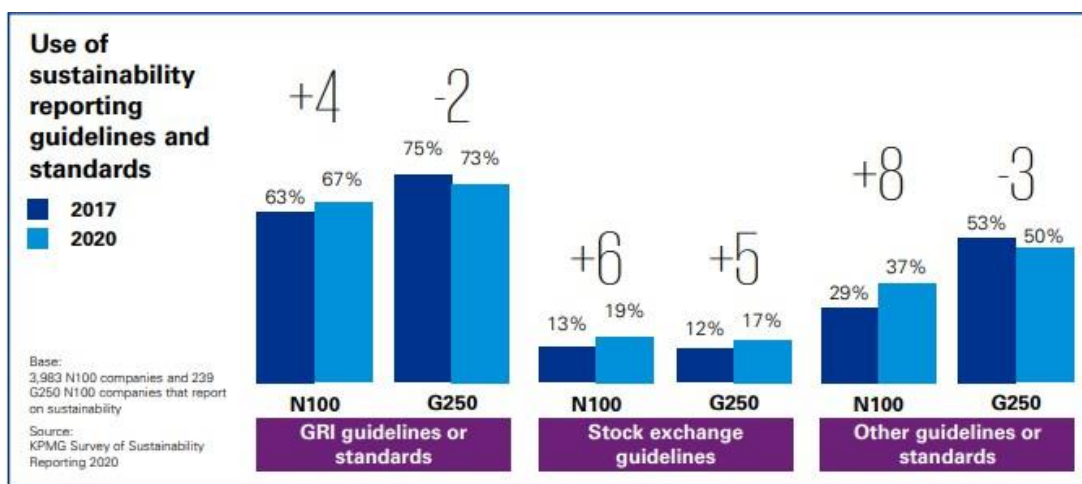


Figure 13: Comparison between NFRD and CSRD

### 1.6.3 Global Reporting Initiative - GRI

The increasing popularity of sustainability reporting has almost naturally led to the development of various guidelines and standards. These tools were created to support organizations in drafting their reports and selecting relevant issues to be included in them. Mainly, for a company, the choice of which standards to use is not unidirectional and may depend on multiple factors such as the geographical area, the material issues of the company, or the sector in which it operates. The most-widely-used standards are certainly the ISO and GRI, however, it should be noticed that both do not consider the financial aspects of companies. The SASB standards, on the other hand, aim to externalize the financial opportunities and risks associated with sustainability reporting and encourage sustainability reporting in companies. The GRI (Global Reporting Initiative), is a non-profit institution aiming at setting sustainability reporting parameters for different sizes and types of companies. It was founded in Boston in 1997 and was initially a division of CERES (Coalition for Environmentally Responsible Economies) created to develop a sustainable accounting system. Specifically, the Global Reporting Initiative is “*the independent, international organization that helps businesses and other organizations take responsibility for their impacts, by providing them with the global common language to communicate those impacts*” (GRI- Global Reporting Initiative, n.d.). The GRI department was later recognized as an independent body in 2002, and the number of activities to which its principles apply was expanded year by year. It is currently based in Amsterdam. Among the tools that GRI provides there are the GRI Standards, i.e. sustainable

development reporting metrics that allow organizations around the world to uniquely and uniformly measure their impact on the planet and make it public in a format that everyone can understand. This impact is measured not only environmentally, but also socially and economically. In this way, the GRI succeeds in pursuing its main objective, which is to provide transparency on the risks, but also on the opportunities offered by activities. The GRI is pioneering in its field, and its standards are now an essential benchmark for sustainability reporting by companies all over the world. According to a KPMG study, in fact, they are even the most widely used standard for sustainability reports, both worldwide and in Italy, with more than two thirds of the companies surveyed using them (KPMG, 2020).



*Figure 14: Use of sustainability reporting guidelines and standards*

Such high use of GRI standards occurs primarily because they are not only regularly audited to reflect global best practices and designed for different types of organizations and stakeholders, but also provide a standardized language for communicating sustainability initiatives, which naturally facilitates external understanding.

Furthermore, the GRI Standards serve as a guide for companies, guiding them towards clear and constructive reporting. In addition, organizations through these indicators can report on an extremely large number of sustainable impacts, in contexts such as social inclusion, climate change and governance structure. Finally, the GRI Standards are highly adaptable to all types of businesses and can be used as a sustainable management control system that reliably measures sustainable performance against targets (GRI - Standards, n.d.).

The GRI Standards are currently divided into three main sections:

- **Universal Standards:** the Universal Standards provide a basis for all GRI reports. They cover topics such as governance, strategy and management approach and apply to all institutions.
- **Sector Standards:** sector standards provide additional guidance for institutions in specific sectors, such as agriculture, manufacturing, and financial services. They therefore apply to specific sectors.
- **Topic Standards:** thematic standards provide detailed guidance on specific topics such as climate change, human rights, and corruption. They therefore apply to specific topics.

(GRI, 2024)

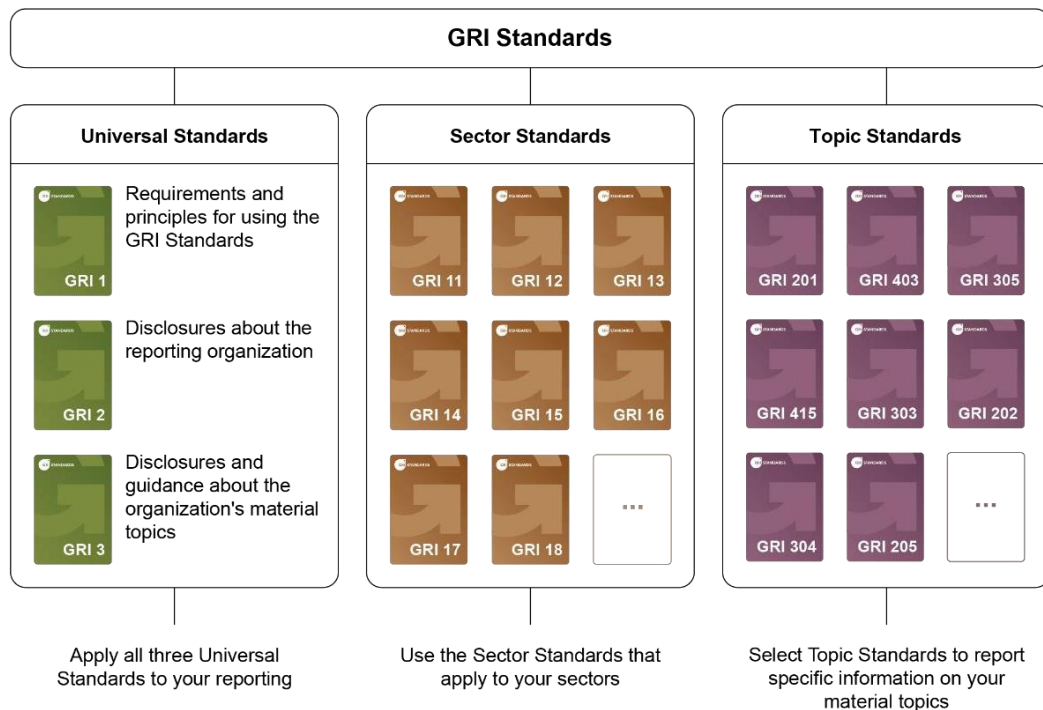
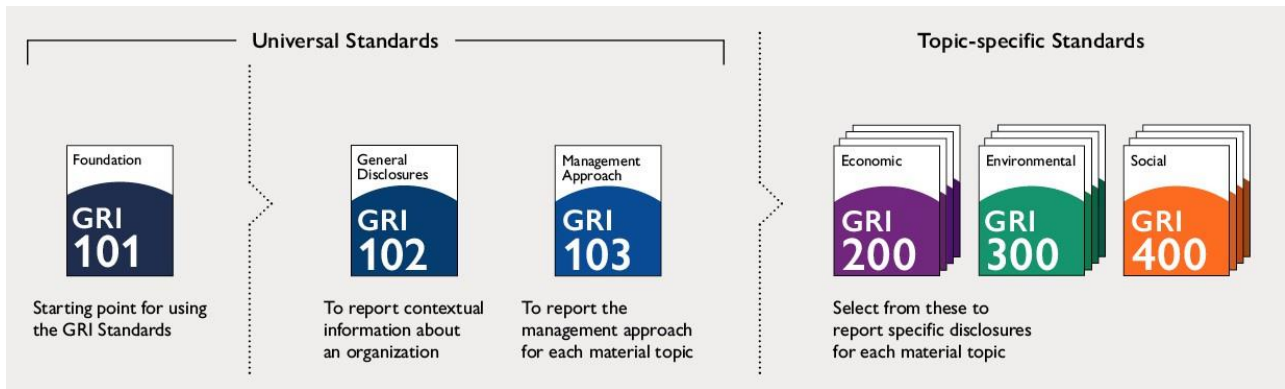


Figure 15: GRI standards scheme

Specific GRI standards can be divided into three broad categories: economic (GRI 200), environmental (GRI 300) and social (GRI 400).



*Figure 16: Universal and Topic-Specific Standards*

GRI 300 are the environmental standards: raw materials used, use of energy and environmental resources, respect for biodiversity, assessment of pollutant discharges and emissions, environmental compliance, supplier assessment. In the context of the GRI Standards, the environmental dimension of sustainability concerns the organization’s impacts on living and non-living natural systems, including land, air, water and ecosystems.

Furthermore, GRIs can essentially contain three types of content: Requirements, Guidelines and Recommendations. The former are the mandatory Guidelines. Requirements are indicated in bold type within the documents and are recognizable because they are characterized by the verb ‘shall/must’. However, an organization may decide not to follow the requirements and still declare itself ‘in line with the standards. Recommendations, then, are not mandatory like requirements, but it is strongly recommended and desirable to follow a certain conduct. Finally, the Guidelines provide information and examples to help institutions better understand the requirements and how to integrate them into their practice (Thompson, 2023).

By using GRI standards in reporting, a society is able to provide a complete picture of its most significant impacts on the economy, the environment and people, taking into account impacts on their human rights and entitlements. This enables users to make informed assessments and choices about the impact of the company and its contribution to sustainable development. The society must fulfil all nine prerequisites in this area in order to produce a report that complies with the GRI Guidelines shown in the image below.

### Overview of in accordance requirements

Requirement 1:	Apply the reporting principles
Requirement 2:	Report the disclosures in GRI 2: General Disclosures 2021
Requirement 3:	Determine material topics
Requirement 4:	Report the disclosures in GRI 3: Material Topics 2021
Requirement 5:	Report disclosures from the GRI Topic Standards for each material topic
Requirement 6:	Provide reasons for omission for disclosures and requirements that the organization cannot comply with
Requirement 7:	Publish a GRI content index
Requirement 8:	Provide a statement of use
Requirement 9:	Notify GRI

Figure 17: Overview of in accordance requirements

If the company does not meet all nine prerequisites, it cannot claim to have prepared the detailed data in accordance with the GRI Standards, however, it may be able to claim to have prepared a report in accordance with the requirements outlined in *'Reporting with reference to GRI Standards'*, for which there is a dedicated section (*GRI*, no date).

In January 2023, the Global Sustainability Standards Board (GSSB)<sup>12</sup>, an independent institution under the Global Reporting Initiative (GRI), planned a revision of the GRI Standards. Thanks to this event, the new Standards have redefined and integrated the concepts of materiality, due diligence, stakeholder engagement and impact (Zanin, 2023). These changes were made to meet the demand for greater transparency and accountability, as required by the IFRS Foundation Reporting Standards published at the end of June 2023 and by the CSRD (Robertadavino, 2024).

Initially, in 2021, the GRI launched the new Universal Standards after a long process of public consultation with numerous international stakeholders such as companies, NGOs, citizens, PAs, etc. In them, important key concepts such as due diligence, impact, material issues and stakeholders are extended and reinforced. It is important to bear in mind, however, that in 2023 there was a major revision of them, thanks to which they were able to be subdivided into their current form in order to increase the transparency, clarity, consistency and comparability of reporting. In addition, they present a clear reference to the new Corporate Sustainability

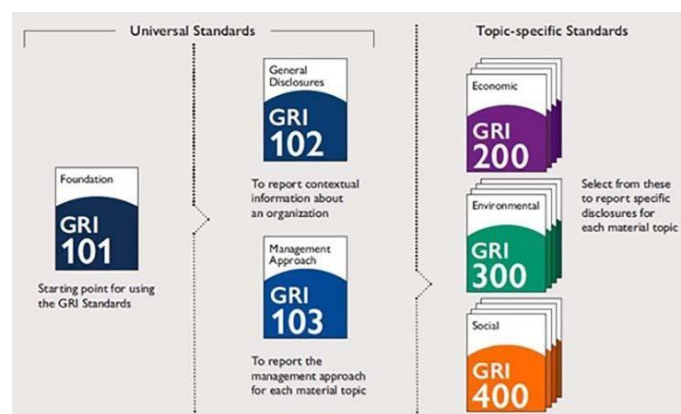
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<sup>12</sup> The GSSB has sole responsibility for setting the world's first globally accepted standards for sustainability reporting that is the GRI Standards. It is an independent operating entity under the auspices of GRI, GSSB members represent a range of expertise and multi-stakeholder perspectives on sustainability reporting. The GSSB works exclusively in the public interest and according to the vision and mission of GRI.

Reporting Directive (CSRD) and the IFRS<sup>13</sup> (International Financial Reporting Standards). Currently, the new GRI indicators are classified as follow: Universal Standards, now revised to incorporate reporting on human rights and environmental due diligence, in line with intergovernmental expectations; the new Sector Standards and The Topic Standards (GRI - Standards, no date).

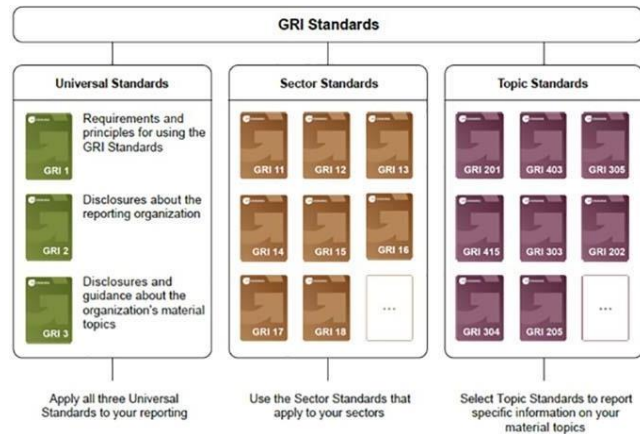
The latter category of standards, which is used to report information on an organization's impacts related to economic, environmental, and social issues, has not undergone substantial changes. The main changes concern the Universal Standards, which form the foundation and establish the methodology to be followed in the reporting process.

Starting with the less intrusive changes, it should be noted that GRI Standards 101-102-103 became GRI 1-2-3. Indeed, with the standards coming into force in 2023, GRI 1: Foundation (replacing GRI 101: 2016) was included. GRI 1 demonstrates the purpose and system of GRI reporting by defining the key concepts, requirements, and principles that companies must adhere to in order to report appropriately to the Standards. GRI 2: General Disclosures (replacing GRI 102: 2016), on the other hand, introduces new disclosures on commitments to responsible business conduct, including due diligence and human rights, and updates some existing disclosures such as governance, stakeholder engagement, corporate strategies, and policies. Finally, GRI 3: Material Issues (replacing GRI 103: 2016), refers to material issues and shows how to use industry standards (Robertadavino, 2024b).



*GRI Standards GRI 2016*

<sup>13</sup> The IFRS Foundation is a not-for-profit, public interest organization established to develop high-quality, understandable, enforceable, and globally accepted accounting and sustainability disclosure standards. Its Standards are developed by two standard-setting boards, the International Accounting Standards Board (IASB) and International Sustainability Standards Board (ISSB). <https://www.ifrs.org/>



*GRI Standards from 2023*

*Figure 18: GRI Standards 2016 vs 2023*

The Universal Standards have been revised with the aim of making reporting a more comprehensive, relevant and adherent process and documents to international principles of due diligence, adopted to identify, prevent and reduce the organization’s negative impacts, responsible governance and respect for human rights. Intergovernmental guidelines that have been used in order to achieve this include the OECD Guide on Due Diligence for Responsible Business Conduct<sup>14</sup> (2018), International Corporate Governance Network (ICGN) Global Governance Principles<sup>15</sup> and OECD Guidelines for Multinational Enterprises (2011)<sup>16</sup>. Another important pillar of the new GRI system is represented by the GRI Sector Standards, which are designed to increase the completeness, consistency, and quality of reported information. They describe the contexts within which the different sectors are developed, suggest their material themes based on their main impacts on SDGs and sustainable development, and for each they list the specific aspects to be reported, considering the associated GRI Topic Standards. The first sectors introduced are ‘Oil and Gas’ (GRI 11), ‘Coal Sector’ (GRI 12) and ‘Agriculture, Aquaculture and Fishing Sectors’ (GRI 13). Furthermore, it is from 2023 onwards that there is no longer a difference between adopting the standards in core (basic) or comprehensive (advanced) mode, and companies will only be able to report their impacts via the options ‘in accordance with (GRI Standards)’ or ‘with reference to (GRI Standards)’.

<sup>14</sup> <https://www.oecd.org/investment/due-diligence-guidance-for-responsible-business-conduct.htm>

<sup>15</sup> <https://www.icgn.org/global-governance-principles>

<sup>16</sup> OECD (2011), *Guidelines for Multinational Enterprises, 2011 edition* (2011). <https://doi.org/10.1787/9789264115415-en>

Finally, the Topic standards have been mainly revised in form based on the latest developments. In conclusion, therefore, as of 2023, the Universal, Sectoral and Specific Standards started to be used as one interconnected set of modular reporting. In fact, the new version of the standards includes a new approach to materiality that includes the concept of due diligence and reinforces that of impact, helping to paint a comprehensive picture of business risks and long-term value creation. Industry experts and stakeholders must, therefore, be actively involved throughout the impact analysis and management process. (De Masi Gervasi, 2007)

#### 1.6.4 European Sustainability Reporting Standards - ESRS

The CRSD introduced new reporting requirements to which listed EU SMEs and large companies must adhere. In particular, it has extended to about 50,000 companies and made it mandatory for them to report on their corporate sustainability through appropriate instruments such as the Sustainability Report, which must report how the company is doing in ESG areas and implement so-called disclosure, i.e. reporting on the extent to which its activities are sustainable to existing reporting standards such as the TCFD<sup>17</sup> and GHG Protocol<sup>18</sup>. According to several experts, ESRS requires more precision in the details of the reported data, also adds a financial perspective and is somewhat stricter (Cambosu, 2024).

The ESRS (European Sustainability Reporting Standards) provide guidance for the consistent disclosure of sustainability information, in accordance with Directive (EU) 2022/2464 of the European Parliament and of the Council, which promotes transparency and accountability in business activities. Furthermore, they establish responsibilities for the preparation and disclosure of clear and complete data on aspects such as materiality, completeness, and relevance.

Finally, ESRS provides guidelines for the disclosure of sustainability policies, risks and opportunities, and a company's business model. This allows users of the guidelines, such as investors, customers, employees and other stakeholders, to assess the sustainability impact of a company and make informed decisions.

About ESRS, Mairead McGuinness, Commissioner for Financial Services, Financial Stability and Capital Markets Union, said: *“The standards we have adopted today are ambitious and are an*

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<sup>17</sup> One of the essential functions of financial markets is to price risk to support informed, efficient capital-allocation decisions. The Financial Stability Board (FSB) created the TCFD to develop recommendations on the types of information that companies should disclose to support investors, lenders, and insurance underwriters in appropriately assessing and pricing a specific set of risks—risks related to climate change. <https://www.fsb-tcfid.org/about/>

<sup>18</sup> GHG Protocol supplies the world's most widely used greenhouse gas accounting standards and guidance. <https://ghgprotocol.org/standards-guidance>

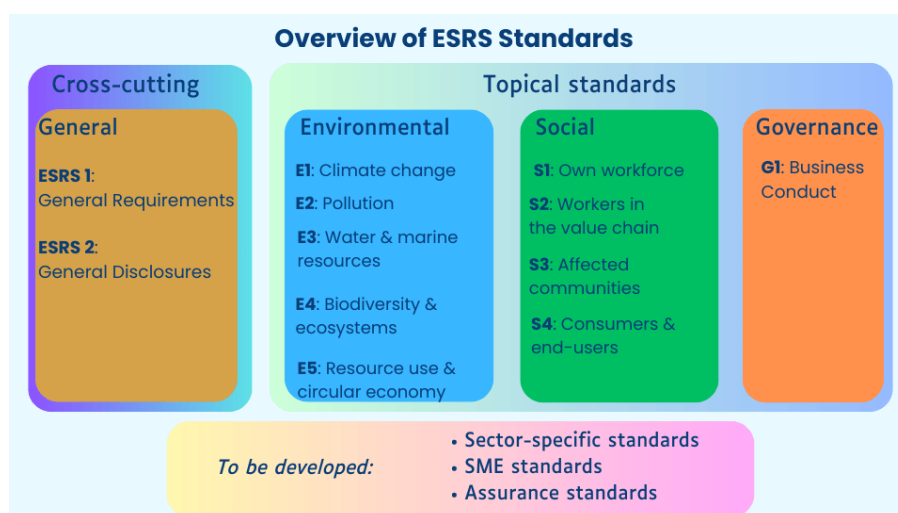


*important tool underpinning the EU's sustainable finance agenda. They strike the right balance between limiting the burden on reporting companies while at the same time enabling companies to show the efforts they are making to meet the green deal agenda, and accordingly have access to sustainable finance.” (European Commission, 2023)*

Unlike the previous directive (NFRD), which allowed companies to independently choose a reporting standard according to their subjective needs and preferences, with CSRD companies are obliged to adopt the ESRS. The first set of European Sustainability Reporting Standards (ESRS) was published by EFRAG in November 2022-July 2023 and came into force on 1 January 2024.

In its initial form, there are 12 standards indicating CSRD reporting requirements. Specifically, ESRS 1 and 2, which are mandatory for all companies, focus on general requirements, while the other 10 focus on specific areas such as climate change, biodiversity, and water and marine resources.

More precisely, ESRS 1 deals with the structure of the ESRS principles, providing the necessary guidance and highlighting the general requirements for drawing up the required sustainability information, while ESRS 2 defines the mandatory data that a company drawing up a sustainability report must report on issues such as governance, corporate strategy and management of impacts, risks and opportunities. The structure of the ESRS is, of course, also inspired by the three ESG dimensions and is closely linked in particular to environmental issues since the ESRS are closely interlinked with the European Green Deal, EU Taxonomy and CSRD.



*Figure 19: Overview of 12 ESRS Standards*

Among the key concepts of ESRS are therefore, dual materiality, upstream and downstream value chain information and the concept of sustainability due diligence which, in turn, is closely linked to the CSDD, the Corporate Sustainability Due Diligence Directive<sup>19</sup>, approved on 24 February 2024. (Cambosu, 2024)

The European Sustainability Reporting Standards (ESRS) do not require reporting on environmental, social and governance aspects covered by ESRS if it has been assessed that these aspects are not material. In other words, this means that sustainability reporting according to ESRS starts with a materiality assessment, which fulfils certain criteria at the level of impact materiality, financial materiality and in general the principle of double materiality (Prisco, 2024c).

However, it is interesting to note that the European Sustainability Reporting Standards (ESRS) were developed with other sustainability reporting regulations in mind. First, they include PAI indicators<sup>20</sup>, which also address specific social, environmental and governance issues and outline the drawbacks of investing in sustainability factors. Furthermore, the ESRS are coordinated with the Taxonomy Regulation, to avoid further burdening companies with duplicative obligations, and with the Capital Requirements Regulation, i.e. the capital requirements for banks and financial institutions. Moreover, they are fully integrated with ESG aspects.

Since there are many new features, the ESRS will be implemented gradually. Indeed, in the first three years of reporting, organizations have the opportunity to indicate their efforts to obtain value chain information. The aim is to enable users of sustainability reports to understand the effects of sustainability on business, people, and the environment.

With reference to ESRS, the Global Corporate & Sustainability Reporting Topic Team Global Corporate & Sustainability Reporting Topic Team of KPMG stated *“Now the final text of the ESRSs is clear, companies in scope have no time to lose before these standards become mandatory. The scale and ambition of these standards is unparalleled and there are key differences to other international frameworks. Companies need to get ready to meet the challenges and realize the opportunities that enhanced reporting will bring”* (Vaessen, 2023).

Overall, it can therefore be said that the implementation of CSRD and the introduction, and

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<sup>19</sup> In, the Commission adopted a proposal for a Directive on corporate sustainability due diligence. Its aim is to foster sustainable and responsible corporate behaviour and to anchor human rights and environmental considerations in companies' operations and corporate governance. ensure that businesses address adverse impacts of their actions, including in their value chains inside and outside Europe.

[https://commission.europa.eu/business-economy-euro/doing-business-eu/corporate-sustainability-due-diligence\\_en](https://commission.europa.eu/business-economy-euro/doing-business-eu/corporate-sustainability-due-diligence_en)

<sup>20</sup> Principles of adverse impact <https://www2.deloitte.com/nl/nl/pages/legal/articles/pai-disclosures-under-the-sfdr.html>

eventual adoption by companies of ESRS, represents for many companies a major shift in the way they operate and a real “watershed”, as it requires extremely detailed reporting on sustainability. Companies will have to consider several risks, including those related to climate and child labour. Consequently, the adoption of a well-structured governance system and risk management through ERM<sup>21</sup> become crucial (Azzeroadmin, 2023).

### 1.7 State of the art and observations of current sustainability reporting methods

Following the analyses in the previous sections, it is evident that European as well as national regulations are attempting to gradually align sustainability and financial reporting provisions. This process is extremely understandable given that investors' decisions are increasingly based on the data in ESG Reporting and that the latter has also been included in a section of the Management Reporting.

However, it should be borne in mind that this approach is still a long and complex path that implies a cultural and corporate governance change that is not sudden, and that would also require regulatory interventions at multiple levels.

Also important is the contribution made by the Taxonomy Regulation, which describes criteria for assessing an economic activity with regard to climate change mitigation and adaptation (J.P. Morgan Ireland, n.d.), which facilitates the fulfilment of ESG disclosure requirements. In conclusion, CSRD, with its accurate and detail-oriented approach to reporting and its sustainability reporting model, seems promising in ensuring the comprehensibility, completeness, and comparability of sustainability information. A process that, given the increasing digitalization and the amount of data and information in the various corporate contexts, could certainly be supported, speeded up and why not, even improved by tools linked to new emerging technologies and the use of artificial intelligence.

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<sup>21</sup> The COSO "Enterprise Risk Management-Integrated Framework" published in 2004 defines ERM as a “process, effected by an entity's board of directors, management, and other personnel, applied in strategy setting and across the enterprise, designed to identify potential events that may affect the entity, and manage risk to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives” (*COSO ERM Integrated Framework, 2004*)

## CHAPTER 2

### ARTIFICIAL INTELLIGENCE:

#### Latest developments and possible applications in accounting

##### 2.1 Definition of Artificial Intelligence

The historical roots of the term 'Artificial Intelligence' originated during the Dartmouth Conference on Artificial Intelligence in 1956, where some of the leading computer scientists and experts on the subject, such as Oliver Selfridge, Trenchard More, and John McCarthy, initiated the first study based on the principle that *"every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it"* (McCarthy et al, 1995), i.e. every aspect and feature of human intelligence can, in principle, be described so precisely that it can be replicated by a machine. In fact, there is no specific definition of 'artificial intelligence', as it is a concept that is subject to constant change and constantly evolving. McCarthy himself defined it as *"the science and engineering of creating intelligent machines, particularly intelligent computer programs. This is a task similar to using computers to understand human intelligence, but AI should not be limited to biologically observable methods."* (McCarthy, 2007).

Similarly, the Council of the European Union has endeavored to provide a definition of an *"artificial intelligence system"* as a *"software-based system that exhibits behaviour simulating intelligence by, among other things, collecting and processing data, analyzing and interpreting its environment and taking actions, with some degree of autonomy, to achieve specific goals; generating outputs such as content, predictions, recommendations"* (European Commission, 2021) through specific machine learning and deep learning approaches.

Furthermore, the Institute of Chartered Accountants in England and Wales states that Artificial intelligence refers to *"machines undertaking tasks which require some kind of intelligence, which typically refers to things such as learning, knowing, sensing, reasoning, creating, achieving goals and generating and understanding language"*. Recent progress in AI has been based on techniques such as machine learning and deep learning, whereby algorithms learn how to do

things, such as classify objects or predict values, through statistical analysis of large amounts of data, rather than through explicit programming (ICAEW, 2018).

In all the cases cited, the typical abilities of human beings, such as knowing and learning, are recalled, and the techniques recalled are the same as those also found in the European Commission's proposal for a regulation. All in all, then, it can be said that the characteristics, functioning and impacts of artificial intelligence can basically be described as the combination of algorithmic systems and cognitive functions. From this perspective, AI can be seen as the ability of a computer system to emulate human intelligence, i.e. to replicate cognitive functions normally associated with the human mind. This ability includes perceptual and intellectual aspects such as learning, thinking, processing, selection and production of information. As an 'artificial' discipline, it is underpinned by a complex system of algorithms, i.e. a finite set of instructions.

## 2.2 Importance of new Technological Advancements and Their Impact on Accounting

In modern business environments, Artificial Intelligence is of paramount importance, as it has become a driving force for innovation, efficiency and competitive advantage in various sectors. The impact of artificial intelligence on business practices, particularly in accounting and finance, can be described as almost transformative. In the business world, this essentially translates into AI's ability to analyze large amounts of data, automate complex processes and provide useful information. Clearly, this change entails a revolution in decision-making, strategy formulation and the operational efficiency of companies (Wamba-Taguimdje et al., 2020). Specifically, in accounting, AI has automated routine tasks such as data entry and transaction categorization, as well as managing complex processes such as auditing and compliance, significantly reducing the time and resources required for such operations. The integration of AI into business operations has also led to the development of predictive analysis systems and intelligent decision-making processes. These systems use AI algorithms to predict market trends, customer behaviour and financial outcomes, enabling companies to make proactive and informed decisions (Harayama et al., 2021).

Artificial Intelligence has a significant impact in the financial sector, where AI-driven predictive models are used to assess risk, analyze investments and plan financial strategies. These models offer a level of accuracy and prediction previously unattainable. Another relevant aspect of AI in companies is the improvement of the customer experience. AI-based tools such as chat-bots, customized recommendation systems and automated customer service interfaces have

transformed the way companies interact with customers. These tools provide a personalized, efficient and 24-hour service, improving customer satisfaction and loyalty (Nicolescu & Tudorache, 2022).

Furthermore, AI plays a key role in business innovation. It has enabled the development of new products, services and business models, adapted to the changing needs of the market.

In the accounting and finance sector, AI has given rise to fintech start-ups offering innovative financial services, revolutionizing traditional banking and financial institutions. However, despite its many benefits, the adoption of AI in businesses also presents challenges. Data privacy, security and ethical considerations are crucial issues that companies must carefully address in order to exploit the full potential of AI while maintaining trust and compliance with regulatory standards (Wamba-Taguimdje et al., 2020). Furthermore, AI is redefining the landscape of the corporate workforce, as it is able to perform various activities and tasks, especially monotonous and repetitive ones instead of humans, thus allowing physical workers to engage in more strictly strategic, creative tasks that do not necessarily follow a constant and defined operation.

In this regard, Harayama states *“Artificial Intelligence (AI) has automated many routine tasks, leading to a change in the skills required by the workforce. Today, there is a growing need for professionals who can collaborate with AI, interpret its results, and exploit its capabilities to gain strategic advantage”* (Harayama et al., 2021).

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## 2.3 Developments of AI

Artificial intelligence offers various possibilities and opportunities to change our society, both in the world of business and the production of goods and services, and in ethical, social and environmental issues. With reference to this last point, it is therefore important to consider how and to what extent different AI tools have impacted accounting and in particular sustainability reporting.

Artificial Intelligence in accounting could have a wide range of applications and technologies, capable of disrupting the way data is analyzed and processed. In addition, the use of AI would not only automate routine processes, but actually enhance and streamline accounting processes (Krájník & Demeter, 2021), as it allows large volumes of data to be evaluated with extreme precision and in a very short timeframe. In particular, in the field of auditing, the main systems that are having an impact on the tasks performed by professionals are Machine learning, Blockchain, Natural Language Processing (NLP), Robotic Process Automation (RPA) and Business Intelligence and Decision Support System.

### 2.3.1 Machine Learning (ML)

An early example of this impact can be seen in Machine Learning, a technology that uses algorithms to make decisions, recognize patterns and learn and emulate the learning and problem-solving processes of humans. Unlike humans, who learn through experience and practice, machine learning algorithms learn from additional data and multiple patterns. These algorithms autonomously identify complex patterns in the available data and appropriate combinations between variables to create accurate and precise predictions (Sarker 2021).

Especially, ML can be considered a subset of AI that comprises two main predictive approaches, that are supervised learning, in which datasets contain known labels as prediction

targets, and unsupervised learning, in which datasets have no labels (Hastie, Friedman and Tibshirani, 2001).

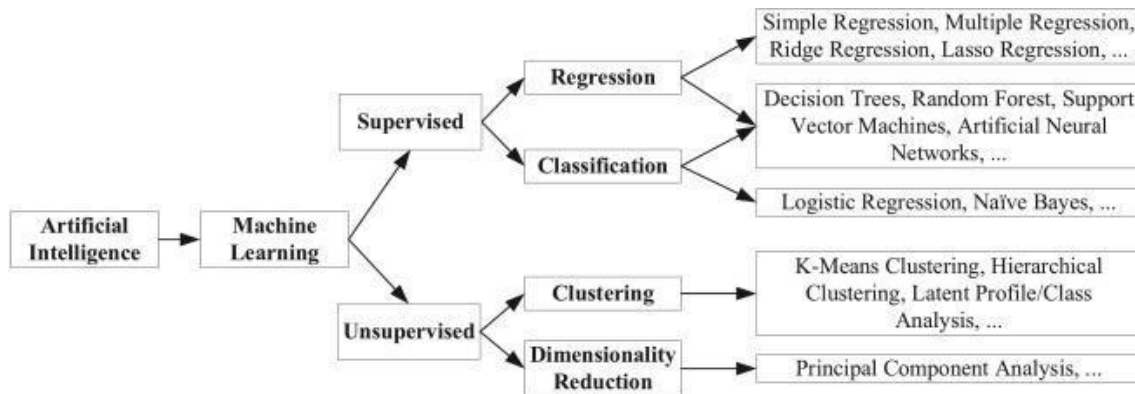


Figure 20: Machine Learning mind map

The ML includes Deep Learning Neural Networks (DLNN), supervised learning and blockchain. Specifically, Deep Learning (DL) can be described as a sub-category of machine learning that refines the existing structure of ML. DL incorporates representation learning, which discovers, and models various patterns and trends needed for detection or classification from unstructured datasets. It relies on artificial neural networks, with algorithms structured in multi-processor layers, to learn complex tasks (Bachouch et al. 2021). These networks replicate human intelligence, reducing manual intervention.

Mainly ML and DL have been used to process images and extract and classify functions, make trend predictions, i.e. in audio-visual recognition contexts. These techniques have been applied in fields such as physical sciences, medicine, energy economics, finance and operations management.

At the financial accounting level, ML and DL are transforming financial and accounting systems, enabling forecasting, analysis and modelling based on complex data.

Indeed, many traditional financial and audit institutions as well as new fintech companies are increasingly adopting machine learning algorithms to improve their services to consumers. Indeed, ML can be used to assess customers' credit risk, forecast exchange rates, analyze stock markets and algorithmic trading models. Financial fraud detection is another field in which ML and DL are widely applied.

Another example could be found in the processing of credit aging<sup>22</sup>, where an algorithm is set

<sup>22</sup> Method used by accountants and investors to find and evaluate any irregularities within a firm's accounts receivables. <https://www.investopedia.com/terms/a/aging.asp>



up to identify customers who should be considered to be in default above a certain maturity range and amount. Essentially, once one has the customer and supplier ledgers, after having checked their completeness and sorted out any squaring, all the analysis relating to the overdue bands of receivables and payables could be carried out by the ML and DL algorithms. In addition, ML allows all the above-mentioned dynamics to be analyzed quickly and accurately, by cross referencing data from rating agencies and other companies, that negotiate with the same counterparties, as well as by calculating any reference KPIs.

### 2.3.2 Large Language Models (LLM)

Large Language Models, also known as LLMs, have become famous due to the role they have played in bringing generative AI to the centre of public interest as well as multiple companies that are focusing on adopting AI in numerous business functions and use cases. They represent a class of deep learning architectures called transformer networks. A transformer model is a neural network that learns context and meaning by tracking relationships in sequential data, like the words in this sentence. (NVIDIA Glossary, n.d.)

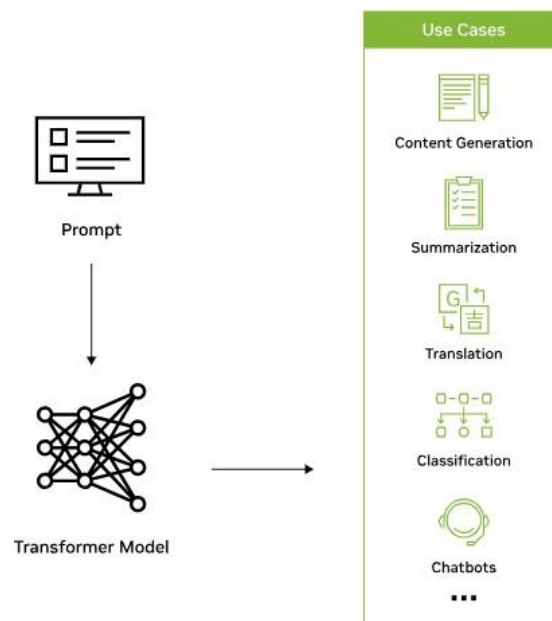


Figure 1. How transformer models work.

*Figure 21: How transformer models work*

They represent a category of artificial intelligence models known as foundation models. These foundation models undergo a pre-training phase in which they are exposed to large amounts of unlabeled data and self-supervision. This process allows models to learn from intrinsic patterns in the data in order to generate output that is adaptable to a wide range of applications. LLMs are particularly targeted at processing written text or similar data, such as computer code. For their training, they draw on huge text datasets, such as books, articles and conversations. The adjective “large” refers to the impressive size of these models, which can occupy tens of gigabytes in terms of storage space and are trained on potentially considerable amounts of data, reaching levels on the order of petabytes, that is  $10^{15}$  bytes. To get an idea of the proportions, a text file of one gigabyte can contain almost 200 million words, while a petabyte is equivalent to about one million gigabytes. In addition to their impressive size, LLMs are also characterized by their large number of parameters. A parameter represents a value that the model can adjust independently during the learning process. In general, the more parameters a model has, the greater its complexity. For example, GPT-3.5, one of the best-known LLMs, is pre-trained on a vast corpus of data that reaches 45 terabytes and uses the incredible number of 175 billion machine learning parameters. (IBM Technology, 2023).

Large Language Models consist of three main elements play a key role: data, architecture and training. On a structural level, it is important to note that LLMs are based on a specific neural network architecture, known as a 'transformer', which is fundamental in enabling the model to handle sequences of data, such as sentences or parts of code. There are two basic components in the transformer: the encoder and the decoder. The former processes the input sequence, while the latter generates the desired output sequence. Transformer operation is based on sequence learning, in which the model receives a sequence of tokens and predicts the next word in the output sequence. This process triggers iterations through various levels of the encoder, allowing it to generate representations indicating which parts of the input sequences are closely related. These representations are then passed on to the next level. Subsequently, the decoder exploits these representations to generate the desired output sequence. In addition, unlike models based on Recurrent Neural Networks, transformers make use of a mechanism called “self-attention” that highlights the relationships between elements in the input sequence, helping to identify the context that attributes meaning to each word within the sequence. Transformers are able to process multiple sequences in parallel, which speeds up training time

considerably. This approach allows for the construction of a detailed understanding of the structure of sentences and the meaning of words within them. Finally, the LLM architecture undergoes an intensive training process on a large amount of data, during which the model trains itself to predict the next word in a sentence. Initially, it makes random predictions, however, through successive iterations, the model adjusts its internal parameters and reduces the discrepancy between its predictions and the actual results<sup>23</sup>.

An interesting question about the application of LLM in the field of accounting, which could be useful to further develop would certainly be whether an LLM, can successfully perform financial statement analysis in a way similar to a professional human analyst. Multiple studies and research, in general, claim that an LLM shows a relative advantage over human analysts in situations where analysts tend to struggle. Furthermore, the accuracy of the LLM's forecasting is quite high and that it generates useful narrative insights based on a company's future performance, rather than on its training memory. Moreover, several trading strategies based on GPT forecasts produce a higher Sharpe ratio and alpha than strategies based on other models.

Returning to the main question of whether an LLM can successfully perform financial statement analysis in a manner similar to what professional human analysts do, it could take quite some time to find a suitable answer, as this would have several far-reaching implications for the future of financial analysis. This answer, then, is far from obvious, as an LLM does not have the deep understanding of a company's financial data that a human expert would have. Moreover, one of the most challenging domains for a language model is numerical, where the model has to perform calculations, human-like interpretations and complex judgements (Brown et al., 2020). Although LLMs are effective in textual tasks, their understanding of numbers typically derives from the narrative context, and they lack deep numerical reasoning or the flexibility of a human mind. Budget analysis, sometimes referred to as fundamental analysis, is a particularly useful context for examining the role of LLMs in future decision-making. Traditionally, financial statement analysis is performed by financial analysts and investment professionals with the primary objective of understanding the financial health of a company and determining whether its performance is sustainable. The various studies show that large language models have similar capabilities to humans in the financial domain.

In particular, table 2 make a comparison of the prediction accuracy of GPT with that obtained by financial analysts. The table shows the forecasting performance of the random walk model, the analysts' forecasts issued one month after the release of previous earnings (Analyst 1m),

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<sup>23</sup> <https://cloud.google.com/ai/llms>

three months after the release of previous earnings (Analyst 3m) and six months after the release of previous earnings (Analyst 6m). Accuracy is considered as the percentage of correct forecasts out of the total forecasts. F1 is the harmonic mean of accuracy and recall.

### GPT vs. Human Analysts

	Accuracy	F1
Random Walk	49.11%	53.02%
Analyst 1m	52.71%	54.48%
Analyst 3m	55.95%	55.33%
Analyst 6m	56.68%	56.85%
GPT (without CoT)	52.33%	54.52%
GPT (with CoT)	60.35%	60.90%

*Table 1: Accuracy of GPT forecasts vs. financial analysts*

Based on the forecasts in the first month following the publication of the previous year's financial statements, the accuracy of analysts is 52.71% and the F1 score is 54.48% when it comes to predicting the direction of earnings one year later. As expected, the analysts' forecast accuracy improves over year  $t+1$ . Regarding GPT forecasts, it can be observed that using a simple prompt instructing GPT to evaluate financial statements and predict the direction of future earnings results in an accuracy of 52.33% and an F1 score of 54.52%. Thus, without the CoT reasoning, the performance of the model is equal to the first month consensus forecasts of financial analysts; however, performance improves when using GPT forecasts based on CoT<sup>24</sup>. While generic language models successfully perform a task that usually requires human expertise and judgement and it does so on the basis of data exclusively from the numerical domain, LLMs clearly have enormous potential to democratize financial information processing and should be of interest to investors and regulators. For instance, findings from several studies suggest that generative AI is not only a tool that can assist investors, e.g. in summarizing financial statements, but can play a more active role in making informed decisions. (Kim et al., 2023). This result is significant, as unsophisticated investors may be inclined to ignore relevant signals (Blankespoor et al., 2019), even if generated by advanced AI tools. However, although it is still unclear whether AI can substantially improve human decision-making in financial markets, the results suggest that certainly LLMs can assume a very important if not central role in the practical and decision-making process in financial statement analysis. (Kim et al., 2024)

<sup>24</sup> Chain-of-thought prompts are known to enhance the model's problem-solving capability and induce human-like reasoning (Wei et al., 2022).

### 2.3.3 Blockchain

Essentially there is a huge variety of definitions of blockchain reflecting how in multiple contexts it is interpreted differently and indicating that a single definition is distant. In general, blockchain is commonly identified as a “*type of distributed ledger technology (DLT) or a type of financial technology (FinTech) (FRC, 2018) or as a sequential database that records transactional information, secured by cryptography, and governed by a consensus mechanism*” (Hinings, Gegenhuber and Greenwood, 2018).

Looking for a more specific definition, the Blockchain, which literally means “block chain”, could essentially be described as a public and shared ledger that functions like an account book, whose model is based on the combination of digital signature and time stamp. (Borsa Italiana, 2022). Such a register is made up of several nodes within the network, whose purpose is to verify the information, send it to the next node and fix it each time to compose, in fact, an immutable chain: every type of transaction is recorded on the register, and since this register is shared, and therefore multiple entities have access to it, the information it contains cannot be modified because there are infinite copies.

Each block contains three key elements: the data, i.e. the details of the transaction, the hash, i.e. a unique alphanumeric code, and the hash of the previous block that is needed to form the chain. In the blockchain, the whole process is self-validating, as there is no central body that guarantees the functioning of the blockchain; rather, it is the nodes themselves that validate and approve each transaction, and it has traceability and limited access, as the blockchain allows precise tracking of transactions and records are only accessible to authorized participants. The advantages are immediately understandable: a decentralized structure capable of writing and validating information without any guaranteeing physical intermediary, organized in a system of nodes. It follows that the integration of blockchain and AI is the perfect match for big data management as it improves transparency and trust, as well as efficiency.

In a more strictly accounting context, the ICAEW refers to blockchain as a distributed ledger system that enables the secure and transparent tracking of asset ownership and the maintenance of a reliable record of financial information. Its constancy stems from trust in the decentralized system that drives record keeping (ICAEW, 2018).

In recent times, more and more studies and implementations of blockchain have been carried out also in accounting, which have led to highlighting the advantages that this tool can also bring in this sector. Some examples could be : the achievement of the scalability of data management and consensus protocols; the creation of value for most types of FinTech

innovations including AI; the enhancement of auditable and verifiable data management to simplify; and even the improvement of business, healthcare, IoT, privacy, and data management within the multiple domains of supply chains (Casino et al., 2019).

Specifically, the fourth largest consulting firms (Deloitte, EY, KPMG, and PwC), are at the forefront of using blockchain technology to improve the efficiency, transparency, and security of all their business operations, and have implemented various technologies at the accounting level as well. For example, EY introduced EY Blockchain Analyzer, a tool that analyses on-chain data to support audit teams in reconciling data between client books and the public ledger. This tool offers an integrated investigation platform for risk management. On the other hand, PwC has released audit software for cryptocurrencies called Halo. This tool helps verify cryptocurrency transactions and provide assurance services to customers who hold or transact with cryptocurrencies. Lastly, KPMG is collaboration with Microsoft, Tomia and R3 to create a blockchain solution to simplify payments in the telecommunications sector with the aim of reducing transaction times and costs by eliminating the need to outsource payments between telephone companies.

### Natural Language processing (NLP)

Natural language processing (NLP) uses algorithms and machine learning to analyze text, allowing large amounts of data to be evaluated faster than manual analysis. It focuses on communication between people and computers and is a subset of AI. This multidisciplinary field draws on psychology, computer science, linguistics, and neuroscience. In addition, NLP is related to text mining, which transforms unstructured text into structured data for analysis. Thus, using natural language processing tools, NLP represents a range of computational techniques for analyzing and representing text, similar to human language processing (Liddy, 2001). This has great potential for improving communication in the areas of accounting, auditing and finance. Studies have applied NLP to knowledge organization and categorization, using financial accounting statements issued by the Financial Accounting Standards Board (FASB) or the Security and Exchange Commission (SEC) EDGAR<sup>25</sup> database. For instance, the

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<sup>25</sup> Publicly owned companies, their officers and major investors are required to file regular disclosures with the Securities and Exchange Commission (SEC). To improve accessibility to these public documents, the SEC began developed the EDGAR (Electronic Data Gathering, Analysis and Retrieval) electronic disclosure system. This system provides ready, free access to all electronic filings made since 1994. (Gerdes, 2003)

EDGAR-Analyzer combined NLP with artificial intelligence to retrieve company-specific data from EDGAR efficiently (Gerdes, 2003).

The use of NLP in these contexts can improve the efficiency and effectiveness of financial statement analysis (Gangolly, Hedley and Wong, 1991). Basically, it can be said that Natural Language Processing (NLP) is a field of artificial intelligence that enables computers to understand, generate and manipulate human language. This approach is fundamental to several applications, including machine translation, voice assistants and social media analysis. However, it should be noted that NLP is still in its infancy and presents challenges such as ambiguity and contextual understanding.

In the accounting and auditing literature, NLP has several future applications. For example, it could be used to evaluate current journal articles, create taxonomies or categorize “*accounting literature by predetermined taxonomic classes.*” (Chakraborty, 2011). However, it remains an open question to what extent NLP can completely replace manual intervention. In the audit field, NLP could be used to inspect the content of some specific auditors’ reports (such as SOX 404<sup>26</sup> ) or to assess companies’ internal risks by examining the characteristics of their reports and disclosures. It is therefore clear that NLP research could not only make significant contributions to the tools of auditors and business managers but also improve the understanding of narrative information in financial markets by exploiting qualitative data that is often overlooked (Boritz et al., 2013). However, although NLP has provided new insights in the fields of accounting, auditing and finance, questions and challenges still remain.

#### 2.3.4 Robotic Process Automation (RPA)

RPA, or Robotic Process Automation, is an artificial intelligence tool that basically allows the automation of repetitive tasks. This tool can handle tasks such as report generation and data entry, allowing accountants to focus on more strategic activities (Gopal, 2024).

RPA is a field that deals with automating repetitive and manual tasks within work processes. Specifically, it aims to replace human intervention in activities that require little added value. For example, it can deal with tasks such as processing data, updating records, sending e-mails or managing workflows. This is done through the use of robot software that mimics human

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<sup>26</sup> SOX compliance is the act of adhering to the financial reporting, information security and auditing requirements of the Sarbanes-Oxley (SOX) Act, a US law that aims to prevent corporate fraud.(IBM, n.d)

behaviour, interacting with computer applications and performing specific tasks. Such robot software are programs that perform specific tasks autonomously. They can be configured to follow predefined rules and interact with other applications via user interfaces or APIs.<sup>27</sup> Unlike traditional automation solutions, RPA can handle both structured data, such as databases, and unstructured data, such as scanned documents or e-mails. In addition, RPA uses certain artificial intelligence technologies to learn and adapt to the operating environment. This means that it can cope with process changes without requiring significant modifications (AI4Business, 2022).

Robotic Process Automation (RPA) is divided into two main categories: attended RPA and unattended RPA. Specifically, in Attended RPA, robots automate interactions with users' desktop applications. They operate within each user's desktop environment, working 'side-by-side' with them.

Consequently, this approach is particularly useful for tasks requiring human interaction and contextual decision-making.

In unattended RPA, on the other hand, robots operate on separate servers or virtual machines and automate interactions with applications 'behind the scenes', without involving the user. This approach, therefore, is ideal for repetitive tasks without the need for direct human interaction. Some technology providers, such as Software AG, support both types of RPA, either separately or in combination. This allows automation to be tailored to specific customer needs.

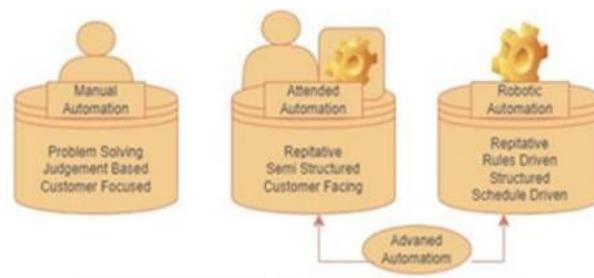
The main advantages of RPA include first of all time savings, as RPA automates repetitive tasks with the speed typical of robots, freeing up time for more complex tasks. In addition, bots never get tired and guarantee constant accuracy. It also has the potential to contribute to increased ROI, as RPA tools are more efficient in handling repetitive tasks than humans and allow qualitative and quantitative data to be collected to manage costs efficiently. Also, note that although human error is inevitable, RPA significantly reduces errors and bots perform tasks accurately and consistently.

Next, RPA reduces human interaction with sensitive data, protecting the company from security threats from, for example, unauthorized access and data breaches. This process also helps improve compliance as it adheres to rules and guidelines with precision or simplifies monitoring and reduces compliance risks. This process automation expands within the organization and can be extremely helpful in addressing seasonal increases in demand and expected targets. Consequently, by automating tedious processes, employees can focus on critical tasks and be more satisfied as they can apply strategic skills.

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<sup>27</sup> Application Programming Interface





*Figure 22: Robotic Process Automation*

### 2.3.5 Business Intelligence (BI) and Decision Support System (DSS)

The increase in the amount of data that make up business management makes it increasingly complex. Among the first archiving tools, mainly used to facilitate management decisions, are the hard disk, the floppy disk and the first Database Management System (DMS), known as Decision Support System (DSS). Specifically, the DSS is a computer system that supports decision-making. With the advent of the third industrial revolution, DSS began to be proposed to companies as the basis of Business Intelligence (BI). The latter can be defined as the aggregation of Data Visualization and Reporting, i.e. the visual representation of data, Business Analytics, i.e. the analysis of historical data to understand current events and predict future trends, Knowledge Management System (KMS), which refers to knowledge management using search engines to retrieve information quickly, and Data Mining and Data Aggregation, which concern the extraction and aggregation of data to represent it graphically. In auditing, the use of BI can be useful for calculating key performance indicators (KPIs), assessing business continuity, and analyzing future scenarios.

Thanks to new technologies, predictive analysis makes it possible to obtain information that is consistent with the market context and in step with any fluctuations.

In addition, artificial intelligence (AI) can be used to generate text in various applications and can be trained to create original narratives as well as be used to produce articles based on facts or data.

AI-based chatbots, among which Chat GPT certainly stands out, use text generation to respond to user queries in a dialogic manner, engaging different stakeholders within and between

organizations on a sustainable and interactive level. Artificial Intelligence is also able to translate text into different languages, but the quality of the generated output is closely related to the goodness of the data and the complexity of the AI model.

Research in the field of accounting has explored the use, implications, and impact of Artificial Intelligence in different contexts and perspectives. For example, Lee and Tajudeen, in their study, examined the use and impact of AI-based accounting software among institutions in Malaysia. They highlighted how the use of this software has improved efficiency, accelerated productivity, supported flexible working styles, enhanced customer service, and increased process governance. (Lee and Tajudeen, 2020)

Lombardi and Secundo, on the other hand, agreed on digital technologies and both financial and non-financial corporate reporting, emphasizing the lack of further research on their intersection. (Lombardi and Secundo, 2020). This point of view is certainly relevant for sustainability reporting; however, business decisions based purely on digitalization could lead to threats to sustainability reporting itself.

Thus, it can be said that the influence of Artificial Intelligence on accounting relates to both operational and strategic efficiency. Indeed, accountants and business leaders can make more informed choices by evaluating various financial trends, especially with regard to risk management, resource allocation and financial strategy formulation. Nevertheless, this application undoubtedly also entails some challenges, particularly in terms of security, data privacy, and ethical considerations. In order to use AI systems correctly, it is necessary to establish strict measures to ensure regulatory compliance and protect sensitive information.

It is clear, therefore, that the introduction of Artificial Intelligence in the field of accounting, if used correctly, brings greater accuracy, efficiency, strategic developments, radically changing the framework of the accounting profession. With the ever-evolving world of AI technologies, it is expected that their role in the accounting industry will deepen further, influencing the skills required of professionals in the field. Undoubtedly, modern accountants must possess a combination of traditional accounting knowledge and technological skills, as understanding and exploiting AI tools has now become an integral part of their role.

## 2.4 Regulatory Context

### 2.4.1. General Data Protection Regulation (GDPR<sup>28</sup>)

The General Data Protection Regulation (GDPR), which came into force in 2018 and applies to organizations that control and process the data of EU citizens, aims to give them greater control and protection over consumers and their data. The regulation aims “*not only to address growing public concerns about the protection of personal data, but also to instil consumer confidence in the digital economy and provide room for its growth*” (World Bank, 2020). In addition, it ensures competition in markets related to personal data.

A closer look at the term ‘data protection’ reveals that this refers to any information that can identify a person, e.g. address, surname, document numbers and/or biometric data. The GDPR also regulates how websites record and manage this information, requiring users' consent and ensuring data security.

This regulation is considered one of the strictest in the world and comprises 99 individual articles. According to Article 5 EU GDPR, which deals with the principles applicable to the processing of personal data, the GDPR is essentially based on 7 principles, which specifically concern: Lawfulness, Fairness and Transparency, Purpose Limitation, Data Minimisation, Data Accuracy, Data Retention Limitation, Data Integrity and Confidentiality, Accountability and Compliance of Organizations with the GDPR (Altalex, 2019).

Specifically, organizations must ensure that data subjects are informed about the purposes and methods of processing their personal data in the course of their work. Data must be collected for a specific and concrete purpose, and the purpose must be communicated in the consent to process the data. Data minimization implies that data must be limited to the minimum necessary for the intended purpose, also as a form of protection in the event of a data breach. The legislation also requires the implementation of reasonable measures to make changes to the data in a timely manner so that they are suitable for the intended purpose. Data accuracy also entails the obligation for the data subject to notify any rectification or deletion of personal data if they are inaccurate or incomplete. Finally, data may only be kept until the purpose for which it was collected is fulfilled.

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<sup>28</sup> General Data Protection Regulation <https://gdpr-info.eu/>

## 2.4.2 Artificial Intelligence Act (AI Act)

One of the main priorities of the European Union has been the promotion of digital transformation. However, the global race to establish technological leadership in artificial intelligence is accompanied by an effort to develop an AI that is also reliable (Laux, Wachter and Mittelstadt, 2023). In this regard, as of 2018, the European Commission and EU Member States have been working together to develop a coordinated legal plan for artificial intelligence in order to develop effective strategies and “*ensure better conditions for the development and use of this innovative technology*” (European Parliament, 2023). Subsequently, in 2020, the European Commission presented a white paper on AI in Brussels, which outlined key objectives, including the safe, ethical and responsible development and use of AI.

The white paper contains policy options aimed at a reliable development of AI in Europe while fully respecting the values and rights of citizens. Its main building blocks are the strategic framework, which sets out measures to align efforts and mobilize resources at European, national and regional levels “*as well as between the public and private sector to achieve an ‘ecosystem of excellence’ across the entire value chain, and the key elements of a future regulatory framework for AI in Europe, which will create a unique ‘ecosystem of trust’*” (European Parliament). To this end, it must ensure compliance with EU rules, including rules protecting fundamental rights and consumer rights.

The White Paper proposes three complementary initiatives:

- Proceeding 2021/0106 (COD), the AI Act, i.e. a legislative proposal establishing horizontal rules on artificial intelligence systems.
- Proceeding 2021/0170(COD), i.e. a revision of sectoral and horizontal rules on product safety (European Commission, 2021).
- Proceeding 2022/0303(COD), i.e. a set of EU rules to address liability issues related to AI systems (European Commission, 2022).

Precisely, in April 2021, the European Commission presented a proposal to regulate artificial intelligence in order to balance the opportunities and risks of this technology through a set of harmonized rules.

Furthermore, the European Parliament also published an own-initiative resolution on AI on 3 May 2022, calling for action to address the digital age.

The AI Act is considered the world's first comprehensive regulatory framework for AI applications. It bans some uses of AI outright and implements strict security and transparency standards for others. *“The Act also creates targeted rules for designing, training and distributing general-purpose artificial intelligence models, such as the foundation models Power ChatGPT and Google Gemini”* (IBM, 2024).

The regulatory approach proposed by the Commission is risk-based and aims to define minimum and flexible requirements that adapt to the evolution of technology. It calls for a clear definition of “artificial intelligence” and a specification of risk levels, which can be high, low or minimal, according to the impact on rights and security. The methodology includes requirements for traceability, documentation, transparency, robustness, and accuracy, especially for high-risk AI systems, with the aim of ensuring compliance with EU fundamental rights and allowing for follow-up checks.

The provisions of the regulation apply both to providers, i.e. developers, and users, who are defined as *“any natural or legal person, public authority, agency or other body using an AI system under its authority, except where the AI system is used in the course of a personal, non-professional activity”* (Council of the European Union, Interinstitutional File).

Looking specifically at some articles of the “Regulation of the European Parliament and of the Council on artificial intelligence COM (2021) 206” (European Parliament, 2022), Article 9 of the Regulation defines the steps of the risk management system when the risk is high. In particular, it provides for continuous monitoring with systematic updates to estimate and assess risks arising from the use of artificial intelligence technology. In addition, Article 12, which deals with traceability, requires the development of these systems to enable *“logs”*, i.e. automatic records throughout the period of use, including input data, persons involved in the verification of results and matches. Human-machine integration is addressed in Article 14, which deals with *“human surveillance”*. It explains that high-risk systems must be designed to understand their capabilities, limitations, malfunctions and failures. Subsequently, in Annex III, the areas in which high-risk AI systems are used are identified, including biometric identification, employment, and access to essential public and private services. The European Parliament’s Amendment 238, adopted in 2023, extends to the committee the possibility to amend Annex III, adding areas that present equivalent or higher risks than those already indicated.

The matter was referred back to the competent committee for inter-institutional negotiations, and the AI ACT was made final in 2024 (European Parliament, 2023).

In March 2024, MEPs approved the regulation resulting from the agreement between the member states of December 2023. The aim was to protect fundamental rights, democracy, the rule of law and environmental sustainability from high-risk AI systems, while promoting innovation and ensuring Europe's leadership in the field. The regulation establishes obligations for AI on the basis of possible risks and level of impact (European Parliament, 2024).

Thus, this law, the first in the world on the subject, dictates a series of obligations to suppliers and developers of artificial intelligence systems based on the different levels of risk identified. These new rules will apply two years after entry into force, with the exception of bans, which will be triggered after six months, controls on artificial intelligence systems for general purposes, including governance, and obligations for high-risk systems (Il Sole 24 Ore, 2024).

#### 2.4.3 Directive on Accountability for Artificial Intelligence (AILD)

In September 2022, the European Commission published the Proposal for a Directive on Accountability for Artificial Intelligence (AILD). Specifically, through a set of rules focusing on respect for fundamental rights and security, the Commission proposed a legal framework for artificial intelligence that is aimed not only at addressing the risks generated by specific uses of AI but also at ensuring that people harmed by AI systems are offered the same level of protection as people harmed by other technologies (European Commission, n.d).

Thus, it represents a significant step towards the regulation of civil liability for damages caused by the use of artificial intelligence systems in Europe. Indeed, the aim of AILD could be summarized as improving the functioning of the internal market by establishing uniform rules for specific aspects of non-contractual civil liability for damage caused with the involvement of AI systems (European Commission n.d).

In this regard, a closer look at the content of the legislation reveals that it has recognized that the opacity of the functioning of AI, its autonomy, continuous adaptation and lack of monitoring capacity present specific challenges to existing liability rules, which this legislation therefore aspires to eliminate.

Furthermore, in the AILD, the boundaries of contractual and non-contractual liability in this area are more precisely defined. Specifically, it is argued that contractual liability arises from

the violation of obligations arising from a contractual relationship, whereas non-contractual liability concerns the violation of the duty not to harm others. It is evident that the latter type of liability, if we consider the contents of Article 2043 of the Civil Code "*Compensation for an unlawful act*", refers to atypical facts in that "*Any wilful or negligent act, which causes unjust damage to others, obliges the person who has committed the act to compensate for the damage*", where "*unjust damage*" identifies the lesion of a legally protected interest (Brocardi, Art. 2043 cc, n.d).

Moreover, it is important to note that the current rules provide that the burden of proof lies with the person suffering the damage.

However, proving wrongdoing by an opaque and complex technology system is very often problematic. In this regard, AILD would introduce a rebuttable "*Presumption of causal link in the case of fault*" to ease the burden of proof for victims in proving harm caused by an AI system. In the directive, specifically in Art 3 which deals with "*disclosure of evidence*", it is foreseen that the party in question may request the disclosure of evidence to support the claim for compensation. Clearly, this could prove particularly useful for damages caused by high-risk AI systems (European Parliament, 2024).

Moreover, as it is often extremely complicated for claimants to prove the causal link between the damage caused by non-compliance with a duty of care and the result generated by the AI tool, Article 4 introduced the "*Presumption of causation in the case of fault*", which is valid unless it can be shown that the claimant has the means to independently access evidence to prove the causal link. For all other AI systems that are not high risk, there is a presumption of causation only in cases where it is extremely difficult for the plaintiff to prove such a link.

The main provisions therefore include, first of all, a system that will require manufacturers of AI systems to take out liability insurance contracts. In essence, therefore, the AILD aims to ensure that persons harmed by AI systems enjoy the same level of protection as those harmed by other technologies. This is an important step towards the accountability and regulation of AI in Europe (European Parliament, 2024).

#### 2.4.4 Overview of Italian AI Legislation

In the field of AI, the Italian ecosystem also possesses considerable potential, although it is not yet fully exploited at the moment. Italian research communities are active, but often small in size and unattractive to foreign expertise. Moreover, there is room for improvement in gender representation and the ability to generate patents. As far as AI solution providers are concerned, the Italian industry is growing rapidly, but the economic contribution is still below its potential, especially compared to other similar European countries. The current context and the international position of the Italian AI ecosystem call for a radical update of the national AI strategy. So, Italy has solid foundations on which to build, but there are also specific areas of weakness that require reforms and targeted investment.

In this regard, then, Italy has adopted the Strategic Programme for Artificial Intelligence 2022/2024, developed in collaboration between the Ministry for Universities and Research, the Ministry for Economic Development and the Ministry for Technological Innovation and Digital Transition.

It aims to promote digitalization and AI in the country. Specifically for the three-year period 2022-2024, the Strategic Programme for Artificial Intelligence in Italy focuses on three main areas of intervention. This program is to enhance skills and attract talent: The aim is to develop an AI ecosystem in Italy, attracting experts and promoting the formation of new skills. This could be done, first by increasing funding for advanced research in AI, that is investing in research and development is essential to maintain technological competitiveness at the international level. In addition, one may get new capabilities by incentivizing the adoption of AI, which includes both Public Administration and the general productive sector.

The Strategic Programme also includes 24 specific policies that have been and will be implemented over the years.



### Riepilogo delle principali politiche previste

Talenti e Competenze	Ricerca		Applicazioni	
			Per le aziende	Per la PA
<b>A.1 Rafforzare il programma Nazionale di Dottorato</b> Aumentare il numero di dottorati di ricerca	<b>B.1 Rafforzare l'ecosistema italiano della ricerca sull'IA</b> Creare un'architettura di ricerca su base hub & spoke con competenze territoriali	<b>B.5 Promuovere campioni nazionali IA multidisciplinari</b> Lanciare sfide su temi specifici con concorrenti valutati sulla base di risultati misurabili	<b>D.1 Fare dell'IA un pilastro a supporto della Transizione 4.0 delle imprese</b> Introdurre crediti d'imposta o voucher per l'assunzione di profili STEM, aggiornamento dell'elenco delle spese software e hardware ammissibili agli incentivi transizione 4.0	<b>E.1 Creare interoperabilità e dati aperti per favorire la creazione di modelli di IA</b> Creare interoperabilità tra le banche dati della PA e mantenere aggiornate le linee guida per Open Data riutilizzabili per modelli di IA con dataset estesi e annotati
<b>A.2 Attrarre e trattenere i ricercatori</b> Attrarre giovani ricercatori beneficiari di borse di ricerca internazionali di alto profilo come l'ERC	<b>B.2 Lanciare la piattaforma italiana di dati e software per la ricerca sull'IA</b> Creare una connessione strutturale di piattaforme nuove ed esistenti, dati e infrastrutture informatiche dedicate all'IA, con librerie open-source	<b>B.6 Lanciare bandi di ricerca-innovazione IA per collaborazioni pubblico-private</b> Promuovere progetti su settori prioritari ma con proposte di libera iniziativa volte a trasferire competenze dalla ricerca alle industrie	<b>D.2 Sostenere la crescita di spin-off innovativi e start-up</b> Promuovere la collaborazione all'interno degli ecosistemi delle start-up; offrire appalti pubblici alle start-up per l'acquisto di beni e servizi	<b>E.2 Rafforzare le soluzioni IA nella PA e nell'ecosistema GovTech in Italia</b> Introdurre bandi periodici per identificare e supportare le start-up con potenziali soluzioni basate sull'intelligenza artificiale per efficientare la PA e migliorarne i servizi
<b>A.3 Rafforzare le competenze di IA nella Pubblica Amministrazione</b> Attivare tre cicli di nuovi corsi di dottorato specificamente progettati per le esigenze generali della PA	<b>B.3 Creare cattedre italiane di ricerca sull'IA</b> Allocare fondi specifici per un unico Principal Investigator (PI), già iscritto ad università o centri di ricerca nazionali, per favorire la collaborazione con industrie ed enti pubblici	<b>C.1 Finanziare ricerca e applicazioni dell'IA creativa</b> Finanziare progetti che integrano la ricerca accademica nel campo di frontiera dell'IA creativa assieme alle sue applicazioni industriali	<b>D.3 Promuovere il go-to-market delle tecnologie IA</b> Promuovere Sperimentazione Italia, uno strumento che consente sperimentazioni attraverso un'esenzione temporanea dalla normativa vigente	<b>E.3 Creare un dataset comune di lingua italiana per lo sviluppo dell'IA</b> Creare una risorsa linguistica aperta e condivisa - una raccolta strutturata di dati digitali da documenti in italiano, disponibili a tutti gratuitamente
<b>A.4 Promuovere corsi e carriere in materie STEM</b> Integrare attività, metodologie e contenuti finalizzati allo sviluppo delle materie STEM nei curricula di tutti i cicli scolastici	<b>B.4 Creare iniziative IA-PRIN per ricerca fondamentale</b> Promuovere bandi dedicati alla ricerca fondamentale sull'IA e sull'IA affidabile	<b>C.2 Promuovere progetti bilaterali per incentivare il rientro in Italia di professionisti</b> Lanciare bandi per progetti incentrati su temi specifici definiti da priorità italiane cofinanziati da un altro Paese con rientro in Italia di almeno un ricercatore	<b>D.4 Supportare le imprese nella certificazione dei prodotti IA</b> Definire un sistema di governance nazionale a supporto della certificazione dei prodotti di IA che si affacciano sul mercato in ambiti con profilo di rischio elevato	<b>E.4 Creare banche dati e analisi basate su IA/NLP per feedback/miglioramento dei servizi</b> Creare dataset annotati e anonimizzati interazioni cittadini-PA per supportare lo sviluppo/integrazione dei fornitori di IA nello sviluppo di servizi PA innovativi
<b>A.5 Espandere l'IA negli ITS ("Istituti Tecnici Superiori")</b> Espandere i corsi di programmazione e includere corsi e stage di IA applicata in tutti i curricula ITS			<b>D.5 Promuovere campagne di informazione sull'IA per le imprese</b> Organizzare azioni di comunicazione e sensibilizzazione sull'IA. Le campagne includeranno la diffusione del Programma strategico nazionale per l'IA agli imprenditori	<b>E.5 Creare banca dati IA/Computer Vision per il miglioramento dei servizi nella PA</b> Creare un dataset annotato di grandi dimensioni con immagini satellitari di paesaggi urbani e rurali, incluse immagini catastali digitalizzate
				<b>E.6 Introdurre tecnologie per condivisione e risoluzione casi trasversali a varie autorità</b> Introdurre tecnologie basate sull'IA per automatizzare lo smistamento e la preparazione delle richieste per l'elaborazione

Figure 23: Summary of the main 24 policies in the Strategic Programme for Artificial Intelligence 2022/2024

These initiatives are key to transforming research results into added value for industry and preparing for the technological and societal challenges of the future.

The National Strategic Programme for Artificial Intelligence is essentially based on five guiding principles:

- Italian AI is European AI: in line with the EU coordinated plan on AI, Italy develops common actions to achieve strategic autonomy and compete internationally. It focuses on cooperation, data and IT infrastructure.
- Italy will be a global hub for AI research and innovation: To ensure future economic growth and strategic autonomy, Italy will invest in frontier research and applications to develop cutting-edge AI methodologies and techniques.
- Italian AI will be anthropocentric, reliable and sustainable: AI must promote economic and social inclusion, respect human rights and ensure environmental sustainability. Italy adheres to the Ethical Guidelines for Reliable AI (Publications Office of the European Union, 2019)

- Italian companies will be leaders in AI research and innovation: Italy promotes the adoption of AI solutions in companies through public-private partnerships.
- Italian public administrations will govern AI and govern with AI: The use of AI in the public sector will follow a dual approach, balancing risk management and optimization of internal processes through the responsible use of data and AI technology (European Commission, 2023)

This programme aims to position Italy as a key player in the global AI ecosystem, promoting innovation, sustainability and strategic leadership.

Given the challenges involved in the use and implementation of AI, as well as Italy's competitive position in the field of AI, this strategic programme outlines six objectives to consolidate the strengths and overcome the weaknesses of Italian AI. Especially, these objectives can be summarized the following points:

- Strengthening frontier research in AI.
- Reducing fragmentation of AI research by helping AI ecosystems to achieve critical mass and promoting network collaborations.
- Developing and adopting human-centred and trustworthy AI in the public and private sectors in line with current standards.
- Increase AI-based innovation by promoting industrial investments and partnerships that transfer research results to the market.
- Develop AI-based policies and services also in the public sector by promoting innovation.
- Create, retain and attract AI researchers in Italy by promoting AI in all levels of education to create a new generation of researchers and innovators.

To achieve the six objectives of this strategy, Italy is committed to investing in eleven priority areas. These include those in which Italy already has a competitive advantage, such as the manufacturing, cultural, agrifood and health sectors, but also strategic industries for the country's technological development, such as national security.

Recently, Agid<sup>29</sup> and the Department for Digital Transformation of the Prime Minister's Office also published the executive summary of the *“Italian Strategy for Artificial Intelligence 2024-2026”*, which outlines a vision to position Italy as a leader in AI-driven innovation.

The strategy is divided into four main strands: research, public administration, business and

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<sup>29</sup> The AgID, that is the Agency for Digital Italy, is the technical agency of the Presidency of the Council of Ministers that ensures the implementation of the objectives of the Italian Digital Agenda by coordinating all the country's administrations. It also contributes to the dissemination of information and communication technologies, fostering innovation and economic growth. Finally, it promotes digital skills and their dissemination, collaborating with institutions, international, national and local bodies. <https://www.agid.gov.it/it/agenzia>

education, reinforced by infrastructural and governance actions. and, on the basis of these, developed the ten key points summarised in the image below:

EXECUTIVE SUMMARY: LA STRATEGIA IN DIECI PUNTI

RICERCA SCIENTIFICA

<p>1. Investire nella ricerca scientifica fondazionale sull'IA, consolidando le iniziative esistenti quali il Partenariato Esteso sull'IA; promuovere la collaborazione tra diverse competenze, finanziando progetti a natura interdisciplinare; aprire il campo all'esplorazione di progetti fortemente ambiziosi e ad ampio spettro (blue-sky); sostenere un piano straordinario per trattenere e attirare i talenti, per sostenere la competitività nel contesto internazionale.</p>	<p>2. Valorizzare la ricerca applicata dell'IA, attraverso iniziative co-progettate da partenariati pubblico-privati, anche con laboratori dedicati che coinvolgono imprese, atenei e centri di ricerca, focalizzandosi sui contesti dal maggiore valore economico e sociale per l'Italia e dal maggiore impatto sul benessere dei cittadini.</p>
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PUBBLICA AMMINISTRAZIONE

<p>3. Supportare i processi amministrativi attraverso le tecnologie dell'IA, aumentando l'efficienza e ottimizzando la gestione delle risorse pubbliche; finanziare alcuni progetti pilota su scala nazionale; sostenere le iniziative delle singole amministrazioni, inquadrando come soggetto collettivo, capace cioè di realizzare soluzioni e applicazioni di IA, e definite in ossequio a precise linee guida di interoperabilità e che garantiscano adeguati standard funzionali.</p>	<p>4. Favorire la fruizione dei servizi della Pubblica Amministrazione per cittadini e imprese, attraverso soluzioni e tecnologie di IA, garantendo l'usabilità, la privacy, la trasparenza dei processi; promuovere la neutralità tecnologica di software e piattaforme della PA per offrire alternative all'utilizzo esclusivo di soluzioni proprietarie.</p>
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IMPRESE

<p>5. Intercettare i bisogni di innovazione delle imprese italiane, finanziando e supportando un ecosistema centrato sull'IA, che sia in grado di qualificare una prospettiva in cui l'eccellenza viene rafforzata da soluzioni tecnologiche orientate a valorizzarne i tratti distintivi.</p>	<p>6. Sostenere il comparto italiano dell'ICT, promuovendone il ruolo abilitante per la definizione di nuove applicazioni di IA, anche con iniziative che rispondano a precise domande di innovazione del tessuto produttivo; accrescere le possibilità di intercettare finanziamenti per sviluppare nuove iniziative progettuali in IA; sostenere e potenziare l'ecosistema delle start-up dell'IA, attraendo capitali pubblici e privati.</p>
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FORMAZIONE

<p>7. Promuovere una formazione universitaria capillare sull'IA, in risposta alle sempre più pressanti richieste di nuove competenze nella società e nel mondo del lavoro, in un'ottica trasversale e interdisciplinare; consolidare la formazione specialistica sull'IA nei percorsi orientati verso profili tecnici e di ricercatori, quali il Dottorato Nazionale sull'Intelligenza Artificiale.</p>	<p>8. Realizzare percorsi educativi sull'IA nelle scuole, per preparare le nuove generazioni a un uso attento e consapevole delle nuove tecnologie; sviluppare iniziative di divulgazione mirate a sensibilizzare e coinvolgere la società italiana nella rivoluzione dell'IA; finanziare e sostenere iniziative di reskilling e upskilling in tutti i contesti produttivi.</p>
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INFRASTRUTTURE

<p>9. Potenziare le infrastrutture che abilitano lo sviluppo e l'adozione di sistemi di IA; finanziare e realizzare un repository nazionale per la condivisione e il riuso di</p>	<p>dataset e modelli acquisiti in progettualità e contesti applicativi legati a iniziative pubbliche.</p>
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ATTUAZIONE, COORDINAMENTO E MONITORAGGIO

<p>10. Istituire una Fondazione per l'IA, con la responsabilità del coordinamento delle azioni strategiche, della gestione di un fondo dedicato e del monitoraggio</p>	<p>dell'implementazione della strategia, in un'ottica di miglioramento continuo.</p>
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Figure 24: Italian Strategy for Artificial Intelligence 2024-2026

So, this National Strategy on Artificial Intelligence is certainly an ambitious plan that implies sharing the strategic vision and coordinated efforts at a technical, financial and organizational level by all the actors involved, but which could allow Italy to take a real leap into the future, opening the door to an Italian Renaissance in the digital era (T.I.A. Italy, 2024)

## 2.5 AI vs. Traditional Accounting Methods

Compared to traditional methods, implementing the integration of Artificial Intelligence in accounting operations has certainly brought about a radical change, leading to real transformations in both analysis and financial reporting. Traditional methods are generally governed by records management and reliance on paper documents and manual data entry. Although they are time-tested methods, they are very challenging, time-consuming and subject to a high rate of human error. Inevitably, these issues reduce their efficiency and speed and make it difficult to manage big data in financial reporting (Zhang et al., 2021).

On the other hand, AI-based accounting techniques make use of advanced technologies such as natural language processing, machine learning and data analysis to improve accounting tasks as well as enhance them. Indeed, AI-based systems are able to quickly rearrange large amounts of data, improving the quality of reporting. This automation can extend to complex tasks such as risk assessment, predictive financial analysis and fraud detection.

In general, it could be argued that the advantages of AI in accounting mainly lie in the fact that it provides real-time analysis, overcoming the delays common to traditional methods, and expands the scope of financial analysis, offering a comprehensive view of a company's financial health and predicting future trends (Meiryani et al., 2022). On the other hand, potential challenges may lie in the fact. First of all, that the use of AI requires specialized skills to interpret and operate the relevant systems. In addition, another major concern relates to regulatory compliance and data security (Zhang et al., 2021).

Overall, the impact of technological advances on accounting has been profound and far-reaching, redefining the landscape of financial reporting and business environments. The integration of digital technologies into accounting practices has not only improved efficiency and accuracy, but also revolutionized strategic approaches to business operations.

First of all, this has come about through accounting automation with AI that automates repetitive accounting tasks, allowing practitioners to focus on more strategic and advisory activities; cross-

checks data in real time, reducing the risk of human error and financial fraud; or even offers advanced analytics for more accurate and personalized advice (Filippi, 2023).

Furthermore, it is important to mention cloud computing, which has changed accounting practices by enabling flexible and scalable solutions, thanks to which businesses can access financial data and accounting applications from anywhere and at any time. Moreover, thanks to blockchain, a new level of security and transparency in financial transactions is offered, which is very useful in the audit industry (Smith, 2018).

So, it can be argued that AI and other technologies are improving efficiency, accuracy and strategic decision-making capabilities in accounting and as these technologies evolve, they will further shape the future of the industry.

On the other hand, while it is true that the digital transformation of accounting has led to numerous benefits, it also presents several challenges. Indeed, despite considerable progress, the digitalization of accounting requires constant learning and adaptability on the part of accounting and financial experts. Acquiring new skills is essential to make the most of available technologies. Moreover, concerns about data privacy and security remain crucial, as the increasing dependence on digital technologies increases the risk of data breaches and cyber- attacks (Shkurti, 2021).

## 2.6 The role of artificial intelligence in improving the analysis and reporting of ESG data

As already stated, ESG reporting is the dissemination of information on a company's social responsibility, corporate governance and environmental impact. Such information has therefore become crucial for investors. However, ensuring the quality of the latter is often a challenge. While, on the one hand, more and more companies provide ESG data, there is often less concrete evidence to support these values. But it is well known that assurance is crucial to ensure that ESG reports are accurate and free of material errors.

Traditional financial audit approaches often do not guarantee the integrity of ESG data. As a result, the complexity of ESG measurements, evolving performance and a different nature of the evidence almost necessitate a revolution in approach. One way to implement such a revolution could be through the use of emerging Industry 4.0 technologies, which would improve not only the efficiency of current ESG auditing techniques but also the way companies produce, manage and distribute their products and resources. This could happen through the integration of new technologies such as the Internet of Things (IoT), cloud computing, analytics, AI and Machine Learning in manufacturing plants and throughout the company's physical and management

operations (Industry 4.0 - IBM Blog, n.d.).

For example, in ESG auditing activities, which can often be an intricate and time-consuming process, especially for small businesses with limited resources, the use of tools such as Big Data, could prove essential to capture evidence from the physical world and provide accurate assurance on ESG reports in a timely manner. More and more, especially in the tech sector, are in fact using Artificial Intelligence to assess and report on their sustainability impact data, among them a key player is undoubtedly Microsoft, which thanks to the Azure platform and all its AI systems collects and analyses data, i.e. consistently publishes documents related to the SDGs, CSR (Microsoft 2023 Annual Report, n.d.) and ESG-related activities, also examining to what extent AI is discussed in relation to these.

## 2.7 Potential of AI across stages of the ESG reporting process

In the ESG reporting process, at the level of management information, it should be noted that since large organizations have a vast amount of management information to analyze, Artificial Intelligence tools have already been used for some time to automate routine tasks and reduce time spent. The use of AI to automate tasks and analyze large amounts of data is set to grow, improving organizational efficiency and optimizing decision-making by reducing human error. Managers have long used financial and non-financial information to make internal decisions, with the Balanced Scorecard being a popular example of practice. The information entered into this system comes from a variety of sources with varying levels of reliability. Financial information tends to dominate decision-making as it is perceived as more reliable than non-financial information (Akbas et al., 2021). As sustainability information is more fragmented than financial information and is often stored in separate systems from the main accounting system, AI could finally provide an integrated solution to combine financial and non-financial management information, a problem with which many institutions struggle (Gibassier et al., 2018). A positive outcome of AI developments could therefore be an increasing perception of the reliability of sustainability information among managers, helping to promote sustainability agendas internally. However, AI systems learn from existing data, which may contain social and cultural biases (Alvesson and Deetz, 2000). These biases may unintentionally be incorporated into AI-generated sustainability reports, perpetuating existing inequalities and overlooking important perspectives. For example, AI might prioritize certain sustainability metrics or priorities that align with dominant cultural values, potentially overshadowing alternative viewpoints.

From a reporting perspective, however, new technologies have already had an impact on the corporate reporting process, with traditional paper-based annual reports increasingly supplemented with interactive digital versions of the same information. Organizations are also using social media tools to disseminate corporate information, both financial and non-financial (Lombardi and Secundo, 2021).

Formats such as XBRL, which are increasingly used in accounting and auditing, allow for greater standardization and offer greater transparency and comparability. In this regard, some believe that fully AI-produced company reports are still a long way off, requiring managers to trust the technology above all because they will be responsible for the content. However, there are clear opportunities for managers to use AI to write sections of reports, modifying the final results (Farooq and De Villiers, 2019). This requires managers to have sufficient knowledge about data and sustainability reporting to exercise judgement. In this context, it is therefore important to recognize how corporate reporting and discourse reflect and perpetuate ideologies. In the case of AI-generated sustainability reporting, the design and programming of AI systems could involve choices influenced by underlying ideologies or value judgements. AI might inherently promote certain sustainability ideologies over others, influencing how companies and stakeholders perceive and give priority to sustainability initiatives.

Regarding audit procedures, whereas traditional audit procedures involved sampling a large number of transactions to form an opinion, AI, with its ability to analyze vast amounts of data quickly, now allows transactions to be audited in their entirety. AI can also be used to test compliance with certain accounting standards and rules. This adds further assurance and frees up time for more subjective reporting areas (FRC, 2019). Real-time reporting can use big data techniques to make audit decisions given certain organizational and environmental contexts. The integration of AI and blockchain could form a system for advanced continuous audits (Han et al., 2023). Institutions need to consider who is responsible for the content generated by AI systems. Ethical concerns may arise if AI generates misleading or inaccurate sustainability information, potentially undermining stakeholder trust. Assurance of non-financial information, including sustainability information, has slowed down developments in assurance of financial reporting because non-financial reporting is voluntary and less reliable for investors (Farooq and De Villiers, 2019; 2020).

However, developments in AI highlight the need for greater assurance of such information.

AI can also help regulators ensure that organizations comply with sustainability and ESG regulations. For example, AI can provide information on sustainability reporting requirements and help regulators assess the accuracy and completeness of sustainability reports submitted by the companies. In addition, AI can support regulators in their enforcement efforts by providing

relevant data and analysis to support investigations and enforcement actions. AI can clearly and concisely explain complex sustainability-related regulations and help communicate the regulator's position on these issues. Regulation is the result of a combination of market forces, ethical ideals and controls. Regulators aim to protect investors by reducing systemic risk and ensuring that markets are fair, efficient and transparent (IOSCO, 2021). Regulators are expressing growing concern about greenwashing. In this context, they could use AI to access relevant information and data on a wide range of topics, including recent regulatory developments related to sustainability.

Although AI can provide regulators with knowledge and expertise on various sustainability-related topics, including best practices and emerging trends in the industry, regulators will need to verify this information by engaging various stakeholders, including investors, customers and the public, on sustainability-related topics.

In addition, AI-generated sustainability reporting introduces the possibility of codifying specific ideologies in the reporting process. The choices made during the design and programming of AI systems are influenced by underlying values and perspectives. This can lead to AI-generated reports that inherently prioritize some sustainability ideologies over others. For example, an AI system may emphasize quantitative metrics over qualitative indicators, fostering a technocentric approach to sustainability that may not align with the values of all stakeholders. Such biases may limit the scope of sustainability initiatives and fail to address the diversity of cultural and ethical perspectives (Alvesson and Deetz, 2000). Furthermore, stakeholders may have limited capacity to question or challenge the information presented by AI systems, further reinforcing power imbalances.

## 2.8 Regulatory and Ethical Considerations in AI-Enabled Accounting

The integration of Artificial Intelligence into accounting has necessitated a re-evaluation of regulatory and ethical considerations. The influence of AI in the financial sector has been significant, prompting the creation of a regulatory framework that addresses digital transparency and neutral algorithms. Indeed, the European Union has established guidelines for Member States to implement ethical principles that align financial digitalization with sustainability and the Agenda 2030 Sustainable Development Goals. These ethical values are grouped into principles that must be present in legislation regulating future financial transactions, ensuring their



application within the territory of the EU. Financial digitalization must ensure principles that control risks, creating technically enforceable rules for all sectors, ensuring a level playing field between states without fragmenting the internal market. An impartial and external evaluation is required for each transaction, based on specific and defined criteria that do not violate fundamental rights or security standards established by EU law (Rodriguez, 2022).

The development of AI systems also raises philosophical and legal issues, especially concerning the creation of general Artificial Intelligence. The use and implementation of AI systems can potentially create contentious legal situations in many areas, including data privacy, social security and liability, intellectual property of AI systems, legal personality of AI systems, and ethical standards in the use of AI systems. Legal regulation in the field of AI is lagging behind technological development, with virtually no legal regulation of the terms, conditions and rules for the development, launch, operation, integration into other systems and control of AI technologies. The process of improving the regulatory framework in some countries focuses on contradictions in the legal regulation of AI systems.

Therefore, it is clear that AI has a crucial role in improving the accuracy and efficiency of accounting practices, a significant step forward compared to traditional methods that often required a lot of manual work and were prone to errors.

The integration of AI in accounting has not only simplified routine tasks, but also changed a lot analytical capabilities, enabling forecasting and strategic decisions that were previously unattainable. Although AI integration offers significant benefits, it also presents significant challenges. These include the need for a workforce skilled in AI technologies, concerns about data privacy and security, and the substantial costs associated with adopting and integrating AI into existing systems. Despite these challenges, the benefits of AI in accounting, such as improved operational efficiency, enhanced accuracy in financial reporting and robust decision support, are undeniable. In conclusion, the correct way forward is to favour a balanced approach to the integration of AI in accounting. This implies continuous learning, adaptation to technological advances, and strategic planning to address the challenges posed by AI. It is imperative that accounting stakeholders embrace these changes, investing in training and development to create a workforce competent in AI and data analysis.

Furthermore, a strong focus on ethical considerations and regulatory compliance is crucial to maintain integrity and trust in AI-enhanced accounting practices. As AI continues to evolve, its integration into accounting is set to bring further innovation, redefining the future of the profession and opening up new horizons for exploration and growth in the digi

## CHAPTER 3

### METHODOLOGY

#### 3.1 Description of the methodology and case study at a general level

Accounting is the process of recording, classifying and summarising financial transactions. It provides a clear picture of your organisation's financial health and performance, which can act as a catalyst for resource management and strategic growth (Iwuozor, 2023). Accounting is like a powerful machine into which raw data, i.e. figures, are fed and processed information such as reclassified financial statements, sustainability reports and financial statements are obtained. Consequently, it goes without saying that the integration of artificial intelligence technologies with the latter, as well as with many other business areas such as logistics, marketing and financial analysis, could potentially increase the efficiency of such processes exponentially and thus constitute an extraordinary breakthrough as well as a revolution in business activities and working methods.

Research in these areas, starting with current regulation and the impacts of new technologies on business processes, allows for a multi-disciplinary approach that combines legal, business and accounting perspectives. This approach, together with the analysis of the professional literature, particularly in the context of Big4 or otherwise consulting firms, makes it possible to examine which technologies are actually being used in the field of business processes, and in particular accounting, and how many instead remain only the subject of theoretical models of application, or due to gaps in legislation, practicality and cost (Marroccoli, 2021).

Technological advances are having a significant impact throughout the world, especially in accounting and, in recent times, also in ESG reporting: in order to deal with an ever-increasing amount of financial data, the entire financial sector is keeping abreast of artificial intelligence and blockchain systems that enable it to more efficiently and effectively analyse large amounts of data. The aim of this paper is, in fact, to provide a comprehensive overview in this field by gathering information from articles, publications, and research in order to understand how the auditing profession is evolving in an environment characterised by high-intensity technological advances and how these fit within current and future regulations.

Thanks to a broad conceptual framework, the main contribution is to understand the risks and benefits of a phenomenon that has only recently developed and whose effects will only be

measured with greater certainty in a few years' time. In addition, a number of case studies are proposed that are useful in gaining a concrete understanding of the applications of artificial intelligence in business and accounting, particularly in ESG reporting.

Sustainability and ESG reporting are extremely topical and important issues that require in-depth and focused study in order to be properly understood and managed.

The case studies are based on semi-structured interviews, which are qualitative research methods that combine aspects of structured and unstructured interviews. In a semi-structured interview, the researcher prepares a set of predetermined questions or topics to guide the conversation with the participant, but there is also room for flexibility and follow-up questions based on the participant's answers. This allows for a more conversational and exploratory approach, allowing the researcher to delve into specific areas of interest and gain detailed and nuanced information.

Essentially, then, this kind of interview was chosen for this work since semi-structured interviews allow researchers to explore participants' perspectives, experiences and perceptions in depth. They can bring out rich narratives, personal insights and contextual details that might not emerge in more standardized interview formats. The open-ended nature of semi-structured interviews allows for a holistic understanding of the research topic and captures the complexity of human experiences.

The interviews which lasted about one and a half hours and were based on questionnaire composed by twenty questions, which can be found in Appendix 1 and 2 concerning: Introduction, business context and impact of AI in ESG accounting and reporting; Metrics for evaluating the possible use of AI; Challenges, Benefits and Opportunities arising from the introduction of AI; Impact of AI on operational processes and Personnel; Ethics, Transparency, Data Management and Privacy; and Future of artificial intelligence in the company and specifically in ESG accounting and reporting.

The first company analyzed CIRFOOD, one of Italy's largest companies active in the catering, commercial catering and welfare services sector, aims to illustrate the management of AI application in a business and sustainability context.

MCG CONSULTING SRL, the second case study developed, which deals with the production of IT solutions specializing in information systems in the areas of Administration, Finance, Management Control and Workflow Management, specifically analyses AI tools used specifically for the drafting of an ESG report.

## CHAPTER 4

### CASE STUDIES

Following the analysis of the literature in order to set the context of this paper as well as to understand its current state of advancement and future development prospects, it is useful to concretely analyse case studies in which AI has been applied to concrete business contexts and with a careful management of ESG. Nowadays, although there have been many impactful developments in AI world, also related to accounting and sustainability are still very few companies, using AI specifically to manage ESG risks and Sustainability reporting. However, the two case studies below want to provide a real picture of how AI is perceived in business management, its potential in multiple processes and how it is used specifically in ESG reporting. The first case looks at the company CIRFOOD, which has been implementing artificial intelligence mainly in the area of logistics for a couple of years now, also using it as a tool to measure its impacts on ESG risks. Given the positive feedback at both the internal and external management level, the prospect over time is to extend the use of AI to many more areas of the company, giving fundamental importance to the ESG context and, why not, to reporting on it. The second, on the other hand, illustrates the context of MCG CONSULTING, which uses AI tools specifically to provide its clients with software capable of drawing up a sustainability report.

#### 4.1 CIRFOOD

CIRFOOD<sup>30</sup> is a co-operative company, which is therefore based on the active participation of its members, who work together to face market challenges and achieve common goals and has been a leader in collective catering for over 50 years. CIRFOOD's Board of Directors consists of 15 members, of which 10 are working members and 5 are contributing members. The CIRFOOD Board of Directors took office on 25 June 2021 and will remain in office for three years. CIRFOOD's Management is made up of a General Management and an Operational Management made up of the Managers of the catering company's Territorial Areas: they are responsible for outlining and implementing the most effective and efficient strategic and management lines. It is one of the largest Italian companies in the corporate, school and social catering sector in a

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<sup>30</sup> <https://www.cirfood.com/>

sector comprising some 1,300 companies, with a market share of around 9.3%, according to Cerved data. Thanks to its ability to respond solidly to the stimuli of the environment, the CIRFOOD Group recorded consolidated revenues of EUR 538.1 million, 13.1% more than in 2021, and group equity of EUR 123.7 million.

In addition, it has invested EUR 15 million in innovation, service development, training and people welfare. In recent years, the company has collaborated with Ammagamma, a data science company specializing in Artificial Intelligence solutions for companies. Together they implemented artificial intelligence systems within CIRFOOD's logistics platform and subsequently evaluated the impact of these systems on the environmental and social sustainability of the processes.

This project represents a reference case in the catering sector, as it is the first time that the qualitative and quantitative impacts of artificial intelligence applied to phases of a company's logistics system have been analyzed. The collaboration started in October 2020 and involved an impact mapping phase that began two years later. During this phase, nine CIRFOOD management representatives responsible for the management of raw materials in the Quanta Stock & Go logistics platform were involved. The objective was to understand the perception and strategic vision related to the introduction of artificial intelligence (Cirfood,2023).

The assessment of benefits and effects was conducted through a customized map, which enabled the monitoring and measurement of the impacts generated by the new technology in terms of economic, social and environmental sustainability. CIRFOOD's articulated ecosystem, composed of various stakeholders connected to the territory, guided the decision to apply artificial intelligence algorithms to meal planning and raw material procurement, with the aim of creating good practices that improve the efficiency and positive impact of the processes.

In detail, the implementation of the artificial intelligence solution developed by Ammagamma for CIRFOOD led to important results. First of all, it has led to a reduction of food waste by 15% due to increased process sustainability. In addition, it reduced the storage of raw materials by more than 100 tons and improved warehouse management. This increased productivity potential by monitoring 94% more references and increased forecast accuracy by more than 50 per cent.

The collaboration with Ammagamma, a start-up of engineers from Modena recently acquired by Accenture, not only gave CIRFOOD almost total autonomy in managing innovative projects, but also allowed it to assess the real impact of artificial intelligence on the organizational structure and to identify growth opportunities for personnel.

In fact, in addition to quantifying the economic and environmental effects, a qualitative analysis of the consequences on people was conducted.

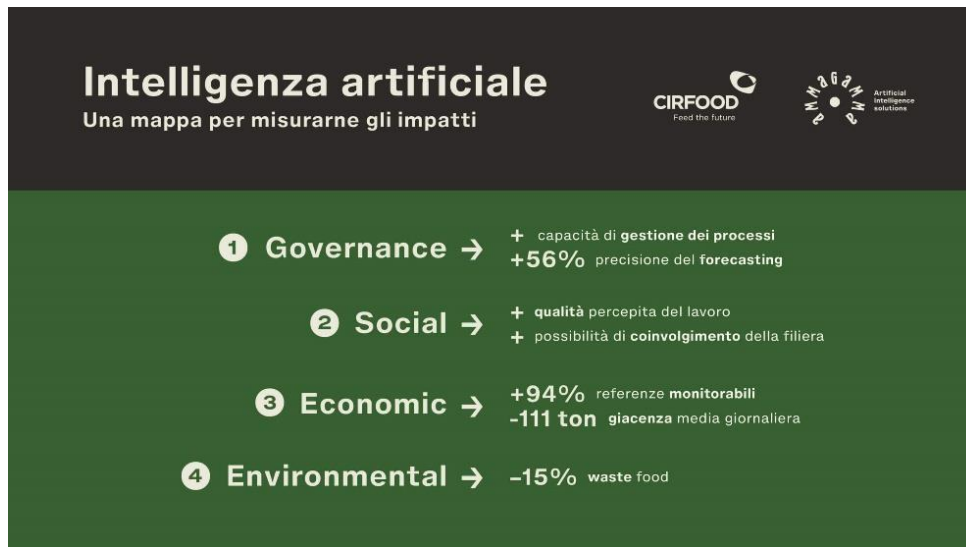


Figure 25: Map to measure the impacts of artificial intelligence in Cirfood

The interlocutors with whom the interview took place were Valentina Dallari, HR Recruiting Specialist, who deals with personnel search and selection, and everything related to employer branding, and Sandro Trotta, Logistic and Supply Chain Manager at CIRFOOD. In their sector, logistics is a strategic asset that is often decisive for a more or less positive balance sheet at the end of the year. Mr Trotta, specifically, leads a team of 8 people and oversees the order acquisition cycle and then reorders to suppliers. They currently use a central platform, to which a second one will soon be added, to sort the goods in order to have an optimal level of service, which means getting everything to the right places and services and keeping stocks low, because in the world of food, goods have a precise shelf-life<sup>31</sup> that must be respected. In fact, Mr. Trotta explains precisely that: *"one of CIRFOOD's main objectives, which is at the same time a challenge, is to achieve and maintain an optimal trade-off between high service and low stock. In addition, it is important to know that the timing of procurement often differs from that of kitchen re-ordering, and the only salvation to manage this correctly is to re-order from suppliers on a forecast basis, rather than on an order basis. The goal of Cirfood is to have demand forecasting that is as adequate as possible, so that reordering to suppliers is done on time and in the correct manner, and also to set intelligent delivery constraints, whereby stock must be managed intelligently and agreements with suppliers must be respected"*.

<sup>31</sup> Shelf life is defined as the time span under defined storage conditions within which a food remains acceptable for human consumption in terms of its safety, nutritional attributes, and sensory characteristics (Bell et al., 1992, Corradini and Peleg, 2006b, van Boekel, 2009, Jedermann et al., 2014a).

It is precisely for this reason that CIRFOOD entered into a partnership with Ammagamma, thanks to which, using machine learning algorithms and the correct setting of demand forecasting logics, it analyzes its current demand and its demand history, finding interrelationships between products with a very high level of accuracy, which the company would certainly never have been able to achieve using Excel alone. The added value that the two companies together gave to the project was precisely that of combining the two types of demand:

- The recent demand, which gives information on consumption trends
- Historical demand, which provides a study of the same period in the year -1/-2, thanks to which they intercept phenomena related to seasonality.

In order to obtain a model with extremely precise and useful data for a more correct and complete demand analysis. Artificial intelligence, therefore, in particular, proved crucial in the final phase of the tests in managing the accuracy of demand, guaranteeing the same level of service but using lower stocks.

The way in which artificial intelligence itself has been introduced into the company has been a gradual transition, as it is of course not easy and straightforward to train staff and adapt business processes to the use of artificial intelligence technologies that one was previously accustomed to performing manually. In this company, the department that benefited most from the help of AI was certainly the supply chain, but there were also great improvements for buyers, who thanks to AI, which assesses commitment in the medium and long term, are able to purchase goods at the best possible price. In this way, buyers have a clear idea of the volumes for the coming season and are able to make better deals rather than over- or underestimating. Specifically, the AI applications currently used by CIRFOOD in their business management could be summarized as the extension of both single- and multi-warehouse best practices, i.e. optimizing stock management; demand optimization; and an appropriate reorder proposal to the supplier.

It goes without saying that greater efficiency in this regard naturally implies greater attention and consequently more careful management of ESG risks. Indeed, the assessment of the benefits and effects of AI implementation was carried out through a customized map that facilitated the monitoring and measurement of the impacts generated by the new technology in terms of economic, social and environmental sustainability. Specifically, with the Politecnico di Milano, CIRFOOD mapped the impact of the methodology with analyses, studies and interviews, and assessed not only the impact of the methodology at the business level, which was positive, but also within the company's processes, personnel and organization, with the final internal

customer. The results were as follows:

- Customer side: most people were totally unaware of the introduction of AI into these business processes; however, they all noticed goods with better shelf life, i.e. less time spent in the warehouse. This translates into the same level of service but improved stock rotation, giving fresher goods.
- Supply chain side: on the logistics staff's side, there was a big effort to change the mindset as the workers had been working in a classic and very 'manual' way for many years, so naturally the introduction of AI meant a sort of slowdown due to training and a little inevitable resistance in both internal and external learning of the workers. However, to date all employees seem to agree that with the introduction of AI it is now possible to spend less time on the operational side and more time on the strategic side. For example, at CIRFOOD, employees have reduced the time spent doing time series in Excel because they now have an ad hoc tool that does this. Therefore, they have more time to devote to project activities, which translates into personal growth as well as more added value to the activities they perform.

Naturally, the introduction of these new technologies brought about the need to acquire new skills and competences that the employees had to acquire, one of the main ones being to learn how to adjust the AI machines and adapt them should any changes arise.

The functioning of the AI-driven logistics platform implemented in CIRFOOD, called Stock and Go, consists first of all in its receipt of all warehouse movements. Then, it performs calculations based on which it produces an output that will be equal to the reorder proposal. This activity used to be done by hand, so the savings in time and effort are certainly evident.

The process also makes it possible to calculate the optimal reorder, which consists of receiving the main stock data, what has gone out and what has already been ordered. By means of precise algorithms, the machine estimates the need and considers the stock to be ordered and ensures that goods arrive at the right time.



Figure 26: <https://www.cirfood.com/>



The impact of artificial intelligence, in business in general but also more specifically in logistics and accounting, is first and foremost measured in terms of days of stock coverage.

Specifically, stocks are measured in stock value, referring to future demand. A careful analysis of the data showed a consistent decrease in days of coverage. A second, and undoubtedly more relevant evaluation metric, is the level of end-customer satisfaction, which is measured by the number of products delivered and ordered, i.e. the number of lines filled in the same time frame, with lower average coverage. In order to measure these impacts, CIRFOOD has used standard KPI's, which measure on an end-to-end basis, and which have enabled it to identify these differences.

Finally, on ethical issues, such as privacy and data security, algorithmic bias, transparency or accountability of actions caused by an AI tool, to protect itself, the company had to disclose and communicate its purchase prices as well as sign an NDA<sup>32</sup>, to keep private non-public information received.

In general, when referring to the impact mapping carried out with the Milan Polytechnic, it is clear that the introduction of AI is undoubtedly helping Cirfood to be more aware of the importance of effectively managing their environmental, social and governance operations, which have the potential to influence not only the companies' financial performance, but also their reputation.

The company's future predictions on the use of AI in their processes are still mainly in the logistics sector, for the transition from a single to a multi-warehouse. Specifically, they wish to keep the one in Reggio Emilia as their main warehouse, but they plan to open another one in Piedmont, so as to understand which warehouse is best for the goods. Furthermore, it is their aim to further exploit new technological tools to be able to calculate even more precisely when and from whom it is convenient to buy goods and how to use their resources. Although in CIRFOOD the main target for the application of AI is still logistics, in line with the resources it has at its disposal, CIRFOOD wants to enhance the application these new technologies also to other business units as well. Specifically, even though CIRFOOD does not currently perform sustainability reporting and is not among the companies obliged to do so in a timely manner according to the CRSD, it wants to maintain a management line that is increasingly geared towards sustainability and compliance with environmental, social and governance criteria, also integrating the use of AI for ESG accounting and reporting activities in the future.

#### 4.2 Mcg Consulting – ECON ESG

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<sup>32</sup> Confidentiality or Non-Disclosure Agreement

Mcg, Management Consulting Group SRL<sup>33</sup>, is a company founded in 1988 dealing in accounting, from the stimulus of textile partners, among them the well-known Rubelli Tessuti. It is a company with only 35 employees but is part of a very solid financial group. Specifically, they specialize in information systems in the areas of Administration, Finance, Management Control and Workflow Management (Management Consulting Group, 2023). In the course of time, customers also started to seek advice on the use and management of their products. The information through which this case study was developed was provided to us by the company's channel manager, Mauro Scanferla.

Specifically, the company could therefore be defined as a software house in an IBM AS400 environment. In the course of time, then, the products have evolved into a windows and web tech cloud environment. Furthermore, MCG consulting sees itself as a dynamic partner for companies that wish to grow by adapting quickly to the constant changes in the market, standards and technologies, and its main objective has always been customer satisfaction. The company's customer base is mainly in the fashion world, with names such as Missoni, Golden Goose and Carrera, and in the world of large-scale retail, with partnerships with clients such as INS, Maffei and Rummo.



Figure 27: <https://www.mcg-econ.it/>

The company has been divided into multiple divisions that specifically deal with

- Treasury
- Document and process management, as in addition to reporting they have to have project governance of people.
- Management control and business intelligence

The idea of realizing ECON ESG started from the fact that there were more and more requests from users, who needed data for non-financial and ESG reporting. So about three years ago the idea was born to realize ECON ESG, a completely independent cloud software dedicated to digital sustainability reporting. It enables rigorous ESG reporting and fact tracking to document

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<sup>33</sup> <https://www.mcg-econ.it/>

its commitment to the goals of an Environmental, Social and Governance plan and to produce the Sustainability Report digitally. As the company realized the vast amount of information in the Sustainability Report and Disclosures, comparisons with other bodies were necessary. Specifically, they approached Etica Leonardo<sup>34</sup>, a training school that holds SRG 88088:20 Social Responsibility and Governance, which is the basis of the Certification Scheme accredited by Accredia for the certification of Sustainability Management Systems for Organizations of all kinds (Accredia, 2022).

MCG studied the business model through the company EFTILIA<sup>35</sup> in Milan, with whom they studied target customers, channels, license matrix, basic and optional functions. After the first sales of the product, customers asked if they should enter everything by hand. Initially yes, but then the company thought about automating the data insertion through a csv import. Thanks to this latest upgrade and the collaboration with Green Future Project<sup>36</sup>, a climate tech company, i.e. an innovative platform dealing with reforestation, CO2 emissions reduction and environmental protection, founded in November 2020, MCG started a water footprint project on denim washing with a fashion company. In this context, tools such as web APIs were used to import and manage data using AI. Specifically, the latter was introduced because certain data, such as qualitative or textual, descriptive data must be inferred, calculated or evaluated. For example, if they refer to the GRI, in MCG to test the truthfulness of the data they perform an assessment of the document with a certifier.

While in order to prove the truth of the data, they use tools, such as OPEN AI and Assembly AI (specialized in text generation), which can also make prospective assessments. The aforementioned tools can be used, for instance, if one wants to reduce CO2 emissions by 50 per cent and consequently needs to assess the company's ability to invest, decarbonize, etc.

Another interesting implementation in AI, introduced by MCG, is the creation of a virtual assistant. Specifically, as soon as a customer signs up, the API is started and an assistant is created, who guides the customer through the configuration and operation to be followed as well as to answer any doubts. For example, if a customer enters a GRI parameter, such as the employee turnover rate, and asks for the percentage, in addition to the validation of the parameter, a call goes out to the assistant who makes sure that the specific GRI rate of the branch has the correct percentage according to the day we are referring to. Then the assistant in evaluating the narrative parts, thanks to the information provided is able to give a star rating of adherence to the GRI or even other standards, according to the criteria of truthfulness, and

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<sup>34</sup> <https://www.scuolaeticaleonardo.it/>

<sup>35</sup> <https://eftilia.it/>

<sup>36</sup> <https://greenfutureproject.com/about>

formal correctness and quality of the text.

In addition, AI was also used in materiality analysis: the company has to choose from the universe of materiality the most important issues and select those that could have a significant impact on the achievement of business objectives. The EFRAG proposal on SME standards, the 'Voluntary ESRS for Unlisted SMEs'<sup>37</sup>, also came to the fore on this.

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<sup>37</sup>[https://www.fondazioneoic.eu/wp-content/uploads/downloads/2024/03/Traduzione-ESRS-VSME-ED 18-marzo-2024.pdf](https://www.fondazioneoic.eu/wp-content/uploads/downloads/2024/03/Traduzione-ESRS-VSME-ED-18-marzo-2024.pdf)

## Appendice B: Elenco delle questioni di sostenibilità

L'appendice di seguito riportata è parte integrante del presente [Bozza di] Principio. La compilazione dei temi di sostenibilità, con i relativi sottotemi e sotto-sottotemi, deve essere utilizzata come base per determinare quali questioni rilevanti devono essere riportate.

Questioni di sostenibilità contemplate nelle [bozze] di ESRS tematici		
Tema	Questione di sostenibilità: Sottotema	Questione di sostenibilità: sotto-sottotema
Cambiamenti climatici	<ul style="list-style-type: none"> <li>– Adattamento ai cambiamenti climatici</li> <li>– Mitigazione dei cambiamenti climatici</li> <li>– Energia</li> </ul>	
Inquinamento	<ul style="list-style-type: none"> <li>– Inquinamento dell'aria</li> <li>– Inquinamento dell'acqua</li> <li>– Inquinamento del suolo</li> <li>– Inquinamento di organismi viventi e risorse alimentari</li> <li>– Sostanze preoccupanti</li> <li>– Sostanze estremamente preoccupanti</li> </ul>	
Acque e risorse marine	<ul style="list-style-type: none"> <li>– Acque</li> <li>– Risorse marine</li> </ul>	<ul style="list-style-type: none"> <li>– Consumo idrico</li> <li>– Prelievi idrici</li> <li>– Scarichi di acque</li> <li>– Scarichi di acque negli oceani</li> <li>– Estrazione e uso di risorse marine</li> </ul>
Biodiversità ed ecosistemi	– Fattori di impatto diretto sulla perdita di biodiversità	<ul style="list-style-type: none"> <li>– Cambiamenti climatici</li> <li>– Cambiamento di uso del suolo, cambiamento di uso dell'acqua dolce e cambiamento di uso del mare</li> <li>– Sfruttamento diretto</li> <li>– Specie esotiche invasive</li> <li>– Inquinamento</li> <li>– Altro</li> </ul>
	– Impatti sullo stato delle specie	Esempi: <ul style="list-style-type: none"> <li>– Dimensioni della popolazione di una specie</li> <li>– Rischio di estinzione globale di una specie</li> </ul>
	– Impatti sull'estensione e sulla condizione degli ecosistemi	Esempi: <ul style="list-style-type: none"> <li>– Degradato del suolo</li> <li>– Desertificazione</li> <li>– Impermeabilizzazione del suolo</li> </ul>
	– Impatti e dipendenze in termini di servizi ecosistemici	
Economia circolare	<ul style="list-style-type: none"> <li>– Afflussi di risorse, compreso l'uso delle risorse</li> <li>– Deflussi di risorse connessi a prodotti e servizi</li> <li>– Rifiuti</li> </ul>	
Forza lavoro propria	– Condizioni di lavoro	<ul style="list-style-type: none"> <li>– Occupazione sicura</li> <li>– Orario di lavoro</li> <li>– Salari adeguati</li> <li>– Dialogo sociale</li> <li>– Libertà di associazione, esistenza di comitati aziendali e diritti di informazione, consultazione e partecipazione dei</li> </ul>

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Figure 28: sustainability issues covered in ESRS <https://www.fondazioneoic.eu/>

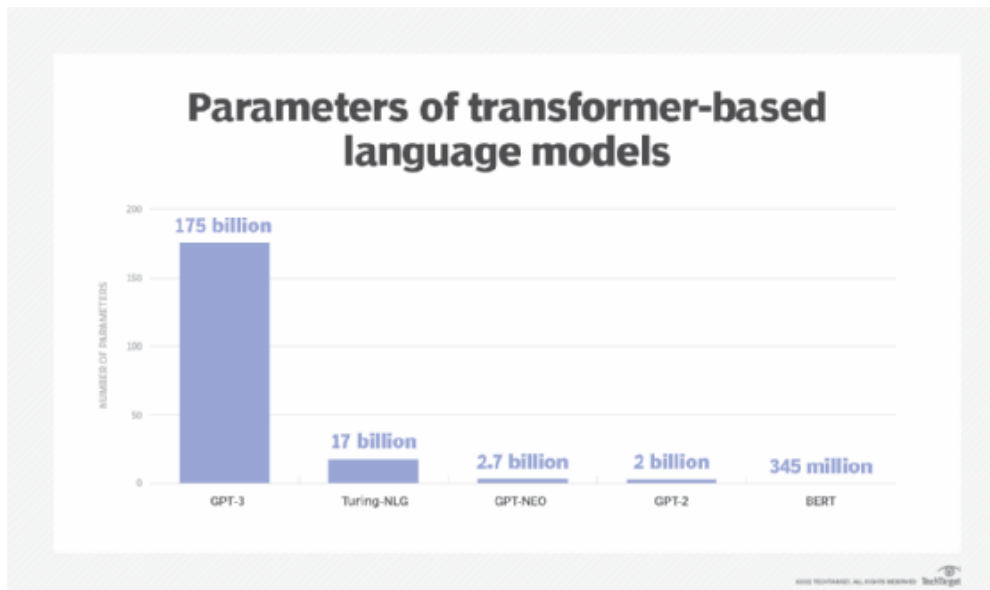
ECON ESG then started to use AI to evaluate the written texts and the association with SDG and GRI, since it is one of the most important steps during the drafting of a sustainability reporting. Subsequently, the company wanted to set up their own search engine, called DALIA, or 'Automatically Read Data with AI'. This tool listens to the conversation and then is able to turn the narrative into a user manual to be divided into chapters. This can be very useful because, for example, customers and people when attending a training session, perhaps take notes but cannot always understand and neatly diagram what they hear. In this case, the AI creates a document with several chapters that then simply needs to be reviewed.

In terms of evaluation metrics, they are indeed not measuring precisely the multiple impacts but, they are still able to get information about it through the use of tokens, log analysis, ...

The company in general has certainly seen an improvement since the introduction of AI, especially with regard to the association with the goal and standard in ESG reporting. *'From a commercial perspective,'* says Mauro, *'the introduction of AI has had a "wow effect", especially in that from the very first request he makes after only a few seconds, the customer already has, in principle, the answer he is looking for'.*

Specifically, ECON ESG is a business unit, very focused on innovation and affiliated with the University of Lugano, with which it carries out multiple projects in the field of sustainability accounting. On a transversal level, it has also had its employees trained on blockchain and AI, thanks to funding from the New Skills Fund. Some employees are obviously only familiar with older programming languages, so there was an inevitable career repositioning as well as the intervention of a specialist in the field to manage the situation as best as possible.

The company's main challenges are to understand the veracity and quality of the information extracted by the AI tools, because the actual level of correctness of the extraction is not yet known for sure. Initially, they used a Large Language Model (LLM), i.e. a deep learning algorithm that has the ability to recognize content, generate it, summarize it, translate it and even predict it if a large amount of data is available, known as 'big data'. In it, however, priority is given to widespread knowledge, and since the company was not too meticulous about sustainability and needed specific data, it judged that it was better to use a Short Language Model (SML), which uses significantly fewer parameters, typically ranging from a few million to a few billion, than LLMs, which have hundreds of billions or even trillions. GPT-4, for example, has 1 trillion parameters, compared to almost 200 billion for GPT-3.



*Figure 29: Parameters of transformer-based language models*

From this point of view, the improvements for MCG have been seen mainly in the use of the virtual assistant, which, after this change, has been able to provide much more precise and detailed data in the ESG area. The next step is to convince employees to associate themselves with the truthfulness of the data.

They were assisted on this by a professor who is part of CONFIMEA<sup>38</sup> and made sure that they belonged to a specific IEC ISO. In general, MCG wants to continue to use this model as well as the previously mentioned AI tools in the future by extending the field of application to other business sectors. In particular, they would like to have the report created entirely by the AI and then maintain only control by the human operator so that the latter can focus more on strategic operations.

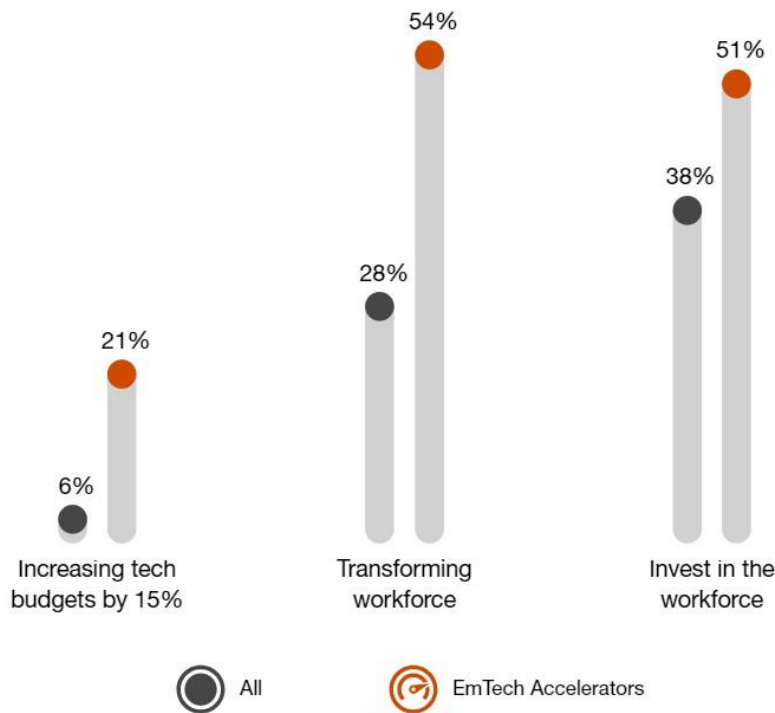
<sup>38</sup> <https://confimea.com/>

## CONCLUSIONS

From the analysis carried out, both in terms of literature reviews and case studies, it can be said that, in conclusion, the use of artificial intelligence in accounting as well as ESG reporting offers significant advantages, but also brings challenges.

PwC carried out a survey which showed that all companies that use artificial intelligence, and more specifically machine learning, manage to provide 34% more service quality than all others, achieve market share faster than their competitors by a margin of 38%, increase profitability and ensure 30% more control over risk. This is made possible by a very high investment in the workforce and a 15% increase in the AI budget. The workforce is transformed, not replaced, by integrating emerging technologies into the existing structure (PwC, 2023).

### Increasing budgets, transforming workforces



*Figure 30: PwC's 2023 Emerging Technology Survey*

Artificial intelligence is therefore an evolving field that seeks to replicate some of the human



cognitive capabilities through the use of algorithms and artificial neural networks. Many companies have started to implement it in their procedures with the ultimate goal of reaching a level of self-sufficiency, where AI can learn automatically from data and perform tasks autonomously, accurately and efficiently. This approach is revolutionizing many business processes, particularly in the most innovative companies, big tech and consulting firms.

At this point, it may be useful to contextualize the present and future benefits and downsides of applying AI in accounting and reporting, in general, but also and especially in the field of sustainability.

First of all, it can be said that it can help accountants to make more accurate predictions since it allows them to analyze a larger amount of data in a shorter time, highlighting areas of interest thanks to the use of peculiar tools like virtual assistants. In addition, AI can help people to focus on more strategic and value-added activities thanks to the automation of standardized activities. AI analytics tools can elaborate huge amounts of real-time data identifying patterns, trends and anomalies which are extremely difficult to spot with traditional accounting methods. Moreover, AI can improve the quality of service provided to clients through more accurate and timely data analysis. AI can analyze large amounts of data to identify trends, anomalies and potential risks, that is build an accurate predictive analysis. This helps accountants make informed decisions and identify areas for improvement. Then, companies using AI, especially ML, can offer a higher quality service than their competitors. This translates into higher profitability and more effective risk control, that is competitive advantage (Attisano, 2024). AI can also adapt to specific needs and learn from experience, constantly improving analysis as well as enabling constant monitoring of customers' financial transactions, on a large-scale context.

Besides, AI tools thanks to its great real-time monitoring capabilities may make the detection of fraudulent activities easier, through continuous analysis of patterns and transactions. Real-time monitoring is an extremely important tool in preventing financial fraud, as it allows for mitigation measure and immediate intervention. Moreover, machine learning algorithms can learn from historical data to find patterns linked to fraudulent activities helping organizations to strengthen internal controls and implement preventive measures. By leveraging pattern recognition, AI helps minimizing the risks associated with fraudulent behaviour and build a more robust financial ecosystem, (Hassan et al., 2023).

On the other hand, for the AI industry there are still many challenges and hurdles to overcome, particularly in accounting and ESG reporting. First, the importance of acquiring a detailed regulatory framework and specific AI skills for accountants must be emphasized, which requires in-depth knowledge of the systems and their outputs. In addition, the implementation

of AI must address cybersecurity challenges, including data breaches, that results in the destruction, loss, unauthorized disclosure or access to personal data stored, transmitted or processed. Another obstacle that slows down the rise of AI consists in the fact that AI outputs depend on the initial data. Indeed, if the dataset is not of high quality, the results may be compromised. It is also important to understand how to properly handle all the employment implications of AI. Similarly, when data with a high level of specificity is required, as in the context of ESG reporting, there is often a risk that AI will provide an output that is too inaccurate and thus not correct enough to produce an accurate and truthful ESG report. In addition, as ensuring data security and privacy has become a primary concern, compliance with data protection regulations, like HIPAA<sup>39</sup> or GDPR, must be granted. As a consequence, firms must apply encryption protocols, security measures, and access controls to safeguard financial data from breaches, cyber threats or unauthorized access. (Adewusi et al., 2024)

In addition to the more operational aspects, AI also has an impact on employment and remuneration. Indeed, when introducing AI in accounting firms, resistance to technological change is a common challenge since accountants may be too loyal to traditional processes and become skeptical about the adoption of AI. (Tiron-Tudor et al., 2022)

From an ethical perspective, it is crucial to understanding how AI algorithms arrive at decisions for both external regulators and internal stakeholders, since transparency and accountability must be ensured. Transparency regards providing clear explanations of AI-driven activities, making it easier for accountants to validate AI-generated insights. Additionally, establishing accountability frameworks is necessary to determine who is responsible for the outcomes of AI-driven decisions and actions (Ayinla et al., 2024).

The aforementioned benefits and difficulties, although not always explicitly stated, are all perfectly adaptable also to the ESG reporting, according to the specific peculiarities of the context. As it was evident from the analysis above, AI offers enormous resources for facilitating and improving ESG reporting: this can be done both through the use of ad-hoc virtual assistants, and through data collection, processing and analysis that will be more accurate and provide more precise predictions using AI tools, due to the fact that they can process larger data pools. On the other hand, it is true that the use of AI, even in an ESG context, may entail the same ethical, privacy and remuneration issues mentioned above. Moreover, it is possible that the information provided by AI may not always be totally correct since, since ESG is a specific, topical and constantly evolving field, which in turn requires a targeted framework and regulations, and even for the most sophisticated AI technologies it is complex to find reliable.

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<sup>39</sup> Health Insurance Portability and Accountability <https://www.hhs.gov/hipaa/for-professionals/index.html>

and up-to-date sources from which to draw analysis and make an accurate selection among them.

The integration between emerging technologies, like blockchain, and AI, constitutes has a potential for transforming accounting practices.

For instance, smart contracts, powered by both blockchain and AI, can automate and execute financial transactions based on predefined conditions, with less need for intermediaries and more accuracy in contractual agreements. Then, thanks to the latest upgrades made in the field of DeFi platforms, enabled by blockchain and AI, the way how financial transactions are managed has been reshaped (Adisa et al., 2021). These platforms automate various financial services, like trading, by using smart contracts and AI algorithms.

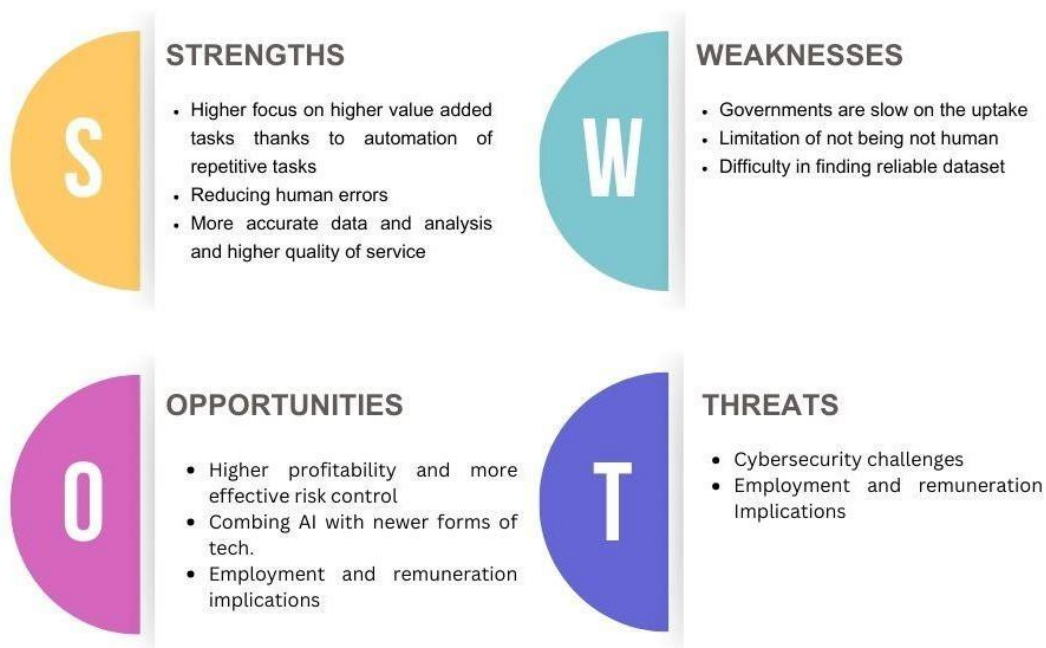
Potentially, future trends in AI within accounting and ESG reporting, will likely see continuous advancements, first of all in machine learning, particularly in predictive analytics (Nembe et al., 2024). Indeed, improved algorithms and models will enable more accurate financial forecasting, risk assessment, and trend analysis while machine learning will evolve to handle larger datasets and dynamic market conditions. Then, the integration of natural language processing can enhance the communication of financial information (Kang et al., 2020). And all these elements, could be particularly positive to manage specific field of accounting, like ESG reporting which requires to get a great amount of precise information in a relatively short time.

The combination of AI with emerging technologies and the development of a consolidated regulatory frameworks will shape the evolution of accounting and ESG reporting practices (Zhang et al., 2020). As these trends unfold, the accounting profession will need to embrace innovation, adapt to technological changes, and explore the regulatory framework to boost the full potential of AI for strategic financial management (Moll and Yigitbasioglu, 2019). The fact of integrating AI into accounting, has brought about significant advancements, transformed traditional practices and enhanced the efficiency and effectiveness of financial processes.

The future of AI in accounting, and probably in ESG reporting, holds immense promise, with ongoing technological advancements, integration with emerging technologies, and the development of robust regulatory frameworks. The relationship of collaboration between accountants and AI systems is likely to become more sophisticated, boosting a synergy that combines the analytical capabilities of machines with the understanding and ethical judgment of human professionals. The journey towards technological integration will undoubtedly shape the future landscape of accounting, offering a symbiotic relationship between human expertise and artificial intelligence.

To better visualize what just stated, it can be useful to summarize the main strengths, weaknesses, opportunities and threats that AI can offer to accounting and ESG reporting in the following SWOT matrix.

## SWOT ANALYSIS



*Figure 31: SWOT analysis: AI in accounting and ESG reporting*

From the research carried out, it emerged that investments have been and are actually being made to adopt AI in accounting and, slower, in ESG reporting procedures because several benefits are derived from its use. The ability to increase the accuracy of services and reduce costs and time allows accountants to focus on high value-added activities, and the collaboration between accountants or ESG experts and artificial intelligence professionals allows for achieving customized solutions for the organization's specific needs.

At the same time, however, the adoption of AI in accounting and ESG reporting poses significant challenges and highlights the need for users and producers to have more detailed information. AI represents a great opportunity for transformation and its potential is increasingly recognized, and in fact, governments are also deploying their resources to provide a more and more appropriate regulatory framework to address the challenges associated with the technologies, provide transparency and define the accountability regime. Artificial intelligence is evolving, and the reliability of algorithms is increasing, so it follows that more and more

accounting and auditing procedures will be joined or replaced by technology. Thinking about artificial intelligence follows a continuous progress and it is important that regulatory adaptations are mapped to develop guidelines that ensure compliance.

Of course, business models will encounter new challenges associated with digital transformation as well as associated with new fields that accounting, ESG and valuation experts will address. The impact on employment and professional skills will also be assessed with a view to creating a positive flow and defining a corporate culture oriented towards new value opportunities and prepared for the development of new techniques and algorithms.

## Appendix 1

### CIRFOOD Questionnaire

#### Introduction and Context:

- Could you briefly introduce yourself and explain your business sector and the role of accounting and logistics/supply chain within it?
- How was artificial intelligence introduced into Cirfood's logistics/operating and accounting area? What were the main objectives?
- How was artificial intelligence specifically implemented within the company? For example, was it a gradual transition or a radical change?
- Which departments or processes have benefited most from the introduction of artificial intelligence?

#### Applications of Artificial Intelligence:

- What specific artificial intelligence applications are you using or have you implemented in your processes? (E.g. data automation, invoice recognition, financial forecasting, pattern recognition, demand forecasting, resource optimization, etc.).
- What specific artificial intelligence applications have been implemented by Ammagamma in Cirfood? How have these applications influenced accounting processes and ESG risk assessment?
- How have these applications improved the efficiency and accuracy of logistics and accounting work?

#### Evaluation Metrics:

- How do you measure the impacts of artificial intelligence (in accounting)? What metrics or indicators are used to evaluate the success of implementations? Use AI to determine evaluation metrics.

### Challenges, Benefits and Opportunities:

- What challenges did the company face in implementing artificial intelligence in both logistics and accounting? How did you overcome them? For example, staff adaptation, integration with existing systems, etc.?
- What opportunities does the company see in using artificial intelligence to improve accounting processes?
- What benefits has the company seen in using artificial intelligence in accounting? E.g. improved efficiency, reduced errors, etc.

### Impact on operational processes and personnel:

- Which operational processes have been affected by artificial intelligence? E.g. inventory management, menu planning, delivery management, etc.
- How has the introduction of artificial intelligence affected the work of staff (accountants) in Cirfood? Have there been changes in the roles or skills required?
- How has the use of AI been received by operational staff? What strategies have you used to engage and prepare employees?
- What measures were taken to ensure a smooth transition for staff? What skills or knowledge were needed to ensure effective collaboration?

### Ethics, Transparency, Data Management and Privacy:

- How does the company handle ethical issues related to the use of artificial intelligence in accounting? (E.g. data privacy, algorithmic bias, etc.).
- What security measures have been taken to protect the privacy of customers and employees?
- How do you ensure that the results generated by artificial intelligence are transparent and understandable?
- How does artificial intelligence handle financial and accounting data?

## Future of Artificial Intelligence in Accounting:

- What are the future predictions regarding the evolution of artificial intelligence in catering?  
Are there new application areas that the company is exploring?



## Appendix 2

### Econ ESG Questionnaire

#### Introduction and Background:

- Could you briefly introduce yourself and explain your business sector and the role of accounting/ESG reporting.
- How was artificial intelligence introduced into ECON ESG accounting/ESG reporting? What were the main objectives?
- How was artificial intelligence specifically implemented within the company? For example, was it a gradual transition or a radical change?
- Which departments or processes have benefited most from the introduction of artificial intelligence?

#### Applications of Artificial Intelligence:

- What specific artificial intelligence applications is the company using or has it implemented in its processes? (For example, data automation, invoice recognition, financial forecasting, pattern recognition, demand forecasting, resource optimization, etc.).
- Which specific artificial intelligence applications have been implemented by ECON ESG? How have these applications influenced accounting processes and ESG risk assessment?
- How have these applications improved the efficiency and accuracy of logistics and accounting work?

#### Evaluation Metrics:

- How do you measure the impacts of artificial intelligence (in accounting)? What metrics or indicators have been used to evaluate the success of the implementations?
- Do you use ai to determine evaluation metrics?
- What tangible results have you achieved so far?

#### Challenges, Benefits and Opportunities:

- What challenges have you faced in implementing artificial intelligence in both logistics and

accounting? How did you overcome them? For example, staff adaptation, integration with existing systems, etc.?

- What opportunities does the company see in using artificial intelligence to improve accounting processes?
- What benefits has the company seen in using artificial intelligence in accounting? E.g. improved efficiency, reduced errors, etc.

Impact on operational processes and personnel:

- Which operational processes have been affected by artificial intelligence? E.g. inventory management, menu planning, delivery management, etc.
- How has the introduction of artificial intelligence affected the work of staff (accountants) in ECON ESG? Have there been changes in the roles or skills required?
- How has the use of AI been received by operational staff? What strategies have you used to involve and prepare employees?
- What measures were taken to ensure a smooth transition for staff?
- What skills or knowledge were needed to ensure effective collaboration?

Ethics, Transparency, Data Management and Privacy:

- How does the company handle ethical issues related to the use of artificial intelligence in accounting? (E.g. data privacy, algorithmic bias, etc.).
- What security measures are in place to protect the privacy of customers and employees?
- How do you ensure that the results generated by artificial intelligence are transparent and understandable?
- How does artificial intelligence handle financial and accounting data?

Future of Artificial Intelligence in Accounting:

- What are the future predictions regarding the evolution of artificial intelligence in catering? Are there new application areas that the company is exploring?
- How is the company preparing for new challenges and opportunities?

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